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INSTALLATION RESTORATION PROGRAM PHASE II - CONFIRMATION/QUANTIFICATION STAGE 1

FOR

TRAVIS AIR FORCE BASE, CA 94535-5300

Volume I - Technical Report

PREPARED BY:

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APRIL, 1986

FINAL REPORT FOR SEPTEMBER 1984 TO APRIL 1986

Approved for Public Release; distribution unlimited

PREPARED FOR

HEADQUARTERS MILITARY AIRLIFT COMMAND
COMMAND SURGEON'S OFFICE (HQ MAC/SGPB)
SCOTT AIR FORCE BASE, ILLINOIS 62225

UNITED STATES AIR FORCE
OCCUPATIONAL & ENVIRONMENTAL HEALTH LABORATORY (USAF OEHL)
TECHNICAL SERVICES DIVISION (TS)
BROOKS AIR FORCE BASE, TEXAS 78235-5501

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STAGE 1

FINAL REPORT
FOR

TRAVIS AIR FORCE BASE, CA 94535-5300
MILITARY AIRLIFT COMMAND
SCOTT AIR FORCE BASE, ILLINOIS 62225

APRIL 1986

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WEST CHESTER, PENNSYLVANIA 19380

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CAPTAIN ROBART W. BAUER
TECHNICAL SERVICES DIVISION (TS)

UNITED STATES AIR FORCE
OCCUPATIONAL AND ENVIRONMENTAL HEALTH LABORATORY (USAF OEHL)
BROOKS AIR FORCE BASE, TEXAS 78235-5501

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A Phase II, Stage I Field investigation and evaluation was conducted at Travis Air Force Base, Fairfield, California, under the auspices of the U.S. Air Force Installation Restoration Program (IRP). The evaluation was accomplished by Roy F. Weston, Inc. (WESTON) as authorized by Task Order 0004 of Air Force Contract No. F33615-84-D-4400. Twelve sites of potential environmental concern, grouped into six waste management zones, were evaluated. A total of 34 monitoring wells were installed and groundwater samples were obtained from each well. Soil samples were obtained for chemical analyses from 13 borings. Samples of storm sewer waters, surface water and bottom sediments were obtained. All chemical analyses were accomplished in accordance with standard USEPA analytical methods. Based on the sampling and analyses performed, levels of contamination were found in soils, sediments, surface water or groundwater at all 12 sites. Based on hese findings, follow-up investigations have been recommended for further groundwater study, either through continued monitoring of existing wells or through

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expansion of the monitoring network, at all 12 sites.

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PREFACE

The purpose of the report is to document the accomplishment of the Phase II, Stage 1, Problem Confirmation Study of the United States Air Force Installation Restoration Program (IRP) at Travis Air Force Base, Fairfield, California. This work was conducted by Roy F. Weston, Inc. under Contract No. F33615-84-D-4400, Task Order 0004.

Mr. Peter J. Marks is Program Manager for this contract. Ms. Katherine A. Sheedy, P.G. managed this Task Order. Laboratory analyses were accomplished at WESTON's laboratory in Stockton, California, under the supervision of Dr. David Ben-Hur. Roy F. Weston, Inc. wishes to acknowledge Capt. Carolyn Jones, USAF, Travis Air Force Base Bioenvironmental Engineer, for her kind assistance in conducting this project.

This work was accomplished during the period October 1984 to August 1985. Capt. Robart W. Bauer, Technical Services Division, USAF Occupational and Environmental Health Laboratory (USAF OEHL/TS), was the Technical Monitor.

Approved:

Peter J. Marks
Program Manager

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EXECUTIVE SUMMARY

ES.1 INTRODUCTION

In 1976, the Department of Defense (DOD) devised a comprehensive Installation Restoration Program (IRP). The purpose of the IRP is to assess and control migration of environmental contamination that may have resulted from past operations and disposal practices on DOD facilities, and possible migration of hazardous contaminants. In response to the Resource Conservation and Recovery Act of 1976 (RCRA), and in anticipation of the Comprehensive Environmental Response Compensation and Liability Act of 1980 (CERCLA or "Superfund"), the DOD issued a Defense Environmental Quality Program Policy Memorandum (DEQPPM) dated June 1980 (DEQPPM 80-6), requiring identification of past hazardous waste disposal sites on DOD agency installations. The U.S. Air Force implemented DEQPPM 80-6 by message in December 1980. The program was revised by DEQPPM 81-5 (11 December 1981), which reissued and amplified all previous directives and memoranda on the IRP. The Air Force implemented DEQPPM 81-5 by message on 21 January 1982. The IRP has been developed as a four-phase program, as follows:

- Phase I -- Problem Identification/Records Search
- Phase II -- Problem Confirmation and Quantification
- Phase III -- Technology Base Development
- Phase IV -- Corrective Action

Only the Phase II Problem Confirmation, Stage 1, portion of the IRP effort at Travis Air Force Base is included in the effort described in the report.

ES.2 SCOPE OF WORK

Travis Air Force Base occupies approximately 5,025 acres in Solano County, California. Since the beginning of military operations in 1943, activities at the Base, in support of mission operations, have resulted in the development of a number of areas suspected of potentially releasing hazardous substances to the environment.

The field investigation described in Task Order 0004 addressed the following 12 areas:

- Storm Sewer Zone.
  - Fire Training Area No. 1.
  - Oil Spill Area.
  - Solvent Spill Area.
  - Storm sewer system.
- Landfill No. 3.
- JP-4 Spill (1978) Area.
- Fire Training Area No. 4.
- Sewage Treatment Plant Zone.
  - Inactive sludge disposal area.
  - Inactive oxidation ponds.
- North Landfill Zone.
  - Landfill No. 1.
  - Landfill No. 2.
  - Fire Training Area No. 2.
  - Fire Training Area No. 3.

The locations of these zones/areas are shown in Figure ES-1.

The scope of the investigation included the following activities:

- The installation of 34 monitoring wells at the investigation sites.
- Collection of soil samples for chemical analysis from selected borings.
- Establishment of 19 surface-water and storm drain sampling locations.
- The collection and analysis of one round of sediment samples from 11 stream locations.
- The collection and analysis of two rounds of water quality samples from all groundwater monitoring wells, storm drains, and surface-water monitoring sites.
- The collection of six rounds of water-level measurements from each well, storm drain, and surface-water station.

Analytes sampled in soil and water included volatile organic compounds (VOA), total organic carbon (TOC), oil and grease, petroleum hydrocarbons, phenols, selected metals, pesticides and herbicides, and potability factors (calcium, magnesium, sodium, alkalinity, sulfate, chloride, nitrate, and total dissolved solids).

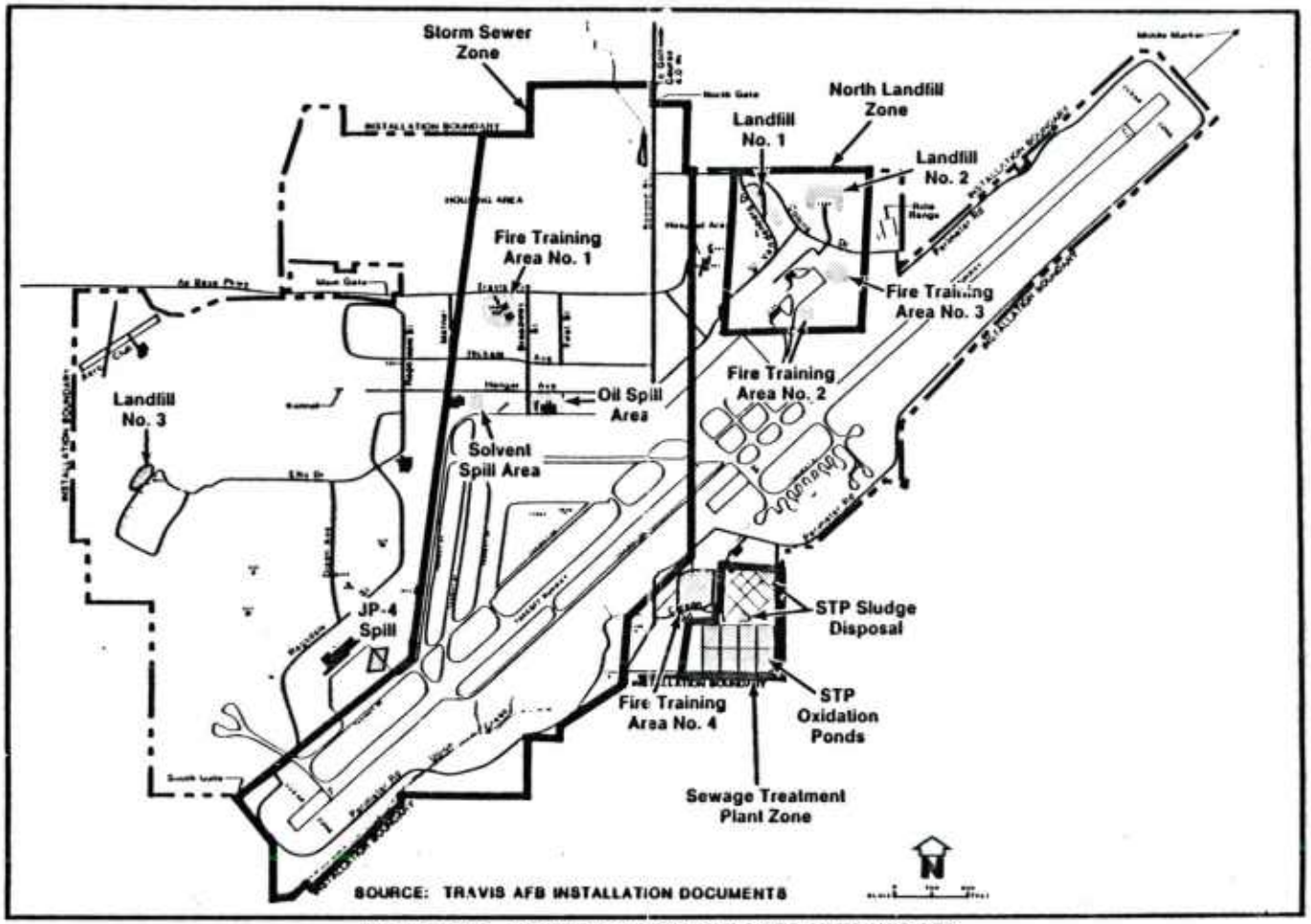

FIGURE ES-1 LOCATION OF PHASE II SITES AT TRAVIS AFB

ES.3 MAJOR FINDINGS

ES.3.1 Hydrogeological Conditions

The following are general conclusions concerning the regional geological and hydrogeological setting at Travis AFB:

- The Base is underlain by alluvium of Pleistocene and Quaternary Ages. The alluvium consists of interfingering and interbedded gravels, sand, silts, and clays. The groundwater occurs under perched, water table, and semi-confined conditions. Due to the low permeability of the sediments, the aquifer is not a major water producer at Travis or in the area surrounding the Base. Groundwater is used to supply small domestic, irrigation, and stock wells.

- The groundwater flow direction in the shallow aquifer beneath Travis AFB is southward toward Suisun Marsh and Bay. Flow directions are not substantially affected by pumping domestic, stock, and irrigation wells south of the Base.

- Due to the depositional environment (lagoonal) of the sediments, the natural water quality contains elevated concentrations of chlorides and total dissolved solids. These concentrations are generally above the California Action Levels established by the California Department of Health Services for drinking water, which have been adopted as guidance criteria for cleanups at hazardous substance sites by the California Water Resources Control Board.

- Groundwater in the area of Travis AFB has been characterized as sodium-bicarbonate or sodium-calcium-bicarbonate type.

ES.3.2 Soil and Water Quality

The following are general conclusions concerning soil and water quality data collected at Travis AFB in the course of this investigation:

- All of the sites where soil and/or sediment samples were collected (FTA-1, Oil Spill Area, Solvent Spill Area, FTA-4, FTA-2, FTA-3, STPZ) exhibited elevated levels of oil and grease or petroleum hydrocarbons. The highest concentration of oil and grease, 2,400 mg/kg occurred in Union Creek at SG-15, in the interval sampled from 4 to 8 inches below ground surface. Within the soil borings, the highest concentration (5,500 mg/kg) of oil and grease was found in a duplicate sample in the 0- to 1.5-foot interval at MW-103. The original sample concentration was 4,500 mg/kg. No Federal or State Action Levels exist for oil and grease or petroleum hydrocarbons in soils and/or sediments. Low levels (<70 mg/kg) of oil and grease may be attributable to natural vegetative decay processes, and can be considered background.

- The highest petroleum hydrocarbon concentration (16,000 mg/kg) occurred in the 0- to 1.5-foot sample at MW-118. Volatile organics were also analyzed in the soils and sediments. The highest concentration found in sediment was 3.4 mg/kg of ethylbenzene in the 8- to 12-inch interval in SG-9. The highest concentration in soil occurred in the 0- to 1.5-foot interval at MW-106 where 0.017 mg/kg of TCE was detected. It can be concluded that the soils and sediments at Travis AFB have been affected by past disposal practices. Under current conditions petroleum hydrocarbons will continue to accumulate at FTA-4 since this is an active fire training area utilizing waste fuels and oils.

- Of the analytes sampled in the storm drains and Union Creek benzene, toluene, tetrachloroethene, trichloroethene, 1,1-dichloroethene, chlorobenzene, and trans-1,2-dichloroethene exceeded or equaled State Action Levels. The major source of contaminants appears to be the storm sewer system itself.

- Potability factors (alkalinity, chloride, nitrate (as N), sulfate, total dissolved solids, calcium, magnesium, and sodium) concentrations varied across the Base. Chlorides and total dissolved solids naturally exceed Federal or state standards, however, in the North Landfill Zone and the Sewage Treatment Plant Zone concentrations of these and other indicators indicate inorganic groundwater contamination.

- Of the volatile organic compounds sampled in groundwater, TCE had the most exceedances of the State Action Level. No major plume is exhibited, implying individual sources rather than one major source are contributing TCE to the groundwater. Other VOC's with exceedances in groundwater include: benzene, 1,1,1-trichloroethane, PCE, 1,2-dichloroethane, 1,1-dichloroethene, and chlorobenzene.

- Pesticides and herbicides were detected at Landfill No. 3, the North Landfill Zone, and the Sewage Treatment Plant Zone. No concentrations exceeded Federal Drinking Water Standards. Total organic carbon (TOC) concentrations varied considerably between sampling rounds and did not prove to be a good indicator. Phenols were only detected in the Storm Sewer Zone in one sampling round. Detected concentrations of mercury in the Sewage Treatment Plant Zone and selenium at Landfill No. 2 exceeded Federal standards in one sampling round.

ES.3.3 Site-Specific Conclusions

As a conclusion to the investigation, each of the sites investigated can be categorized according to whether it requires no further action (Category I), requires further investigation (Category II), or is ready for remedial action (Category III). The following definitions have been used in the classification of investigation sites at Travis AFB:

- Category I applies to sites where no further action (including remedial action) is required because sufficient data exist to rule out unacceptable health or environmental risks resulting from the site.

- Category II applies to sites that have confirmed contamination potentially representing unacceptable environmental or health hazards, and require further investigation.

- Category III applies to sites where remedial action is required and all necessary data to support an analysis of remedial alternatives have been gathered. These sites are considered ready for IRP Phase IV action.

Site-by-site conclusions are summarized in Table ES-1.

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Table ES-1

Summary of Site-Specific Conclusions, Travis Air Force Base Stage 1 Investigation, IRP Phase II

Zone/Area	Investigation Cagetory	Rationale	Supporting Sections of Report
Storm Sewer Zone			
FTA-1	II	Soil samples indicate contamination present at low levels. Water quality data do not exceed standards. Monitoring of contaminant levels required.	4.3.1.1 4.4.2.1
Oil Spill Area	II	Soil samples indicate above background levels of oil and grease. Water quality data found various volatile organics, mainly TCE, exceeding standards. Two additional monitoring wells are needed.	4.3.1.1 4.4.2.1
Solvent Spill Area	II	Soil samples indicate contamination by oil and grease, and TCE. Water quality analyses found various volatile organics, mainly TCE, exceeding standards. Two additional monitoring wells are needed.	4.3.1.1 4.4.2.1
Sewer Right-of-Way	II	Soil, sediment, and water quality samples indicate major contamination by oil and grease, and volatile organics. Intensive investigation into sources needed.	4.3.1.1 4.3.2.1 4.4.2.1
Landfill No. 3	II	Water quality data indicate contamination below standards. Monitoring of contaminant levels required.	4.4.2.2
JP-4 Spill Area	II	Study results do not confirm or deny the area as a contamination source. At least one additional monitoring well needs to be installed.	4.4.2.3

Table ES-1
(continued)

Zone/Area	Investigation Cagetory	Rationale	Supporting Sections of Report
Sewage Treatment Plant Zone	II	Sediment samples indicate oil and grease in the stream. Water quality data indicate exceedances of standards and possible movement off-Base.	4.3.2.2 4.4.2.4
FTA-4	II	Sediment samples indicate above background levels of oil and grease in the stream. Water quality data indicate some exceedances of standards, but most are unconfirmed.	4.3.2.3 4.4.2.5
North Landfill Zone			
Landfill No. 1	II	Water quality data indicate contamination by TCE below standards. Monitoring of contaminant levels required.	4.4.2.6
Landfill No. 2	II	Water quality data indicate small amount of contamination emanating from site. Monitoring of contaminant levels required.	4.4.2.6
FTA-2	II	Soil samples indicate contamination by oil and grease, and TCE. Water quality data indicate some volatiles below standards, but unconfirmed.	4.3.1.4 4.4.2.6
FTA-3	II	Soil samples indicate contamination by oil and grease. Water quality data indicate some volatiles above standards, but unconfirmed. Two additional monitoring wells are needed.	4.3.1.4 4.4.2.6

ES.4 RECOMMENDATIONS

Recommendations for implementation of the alternatives for further investigation on a site-by-site basis are included in this subsection. The site-by-site recommendations are preceded by some general recommendations concerning the handling and disposal of hazardous substances and further monitoring programs associated with the IRP.

ES.4.1 General Recommendations

The following general recommendations are made:

- The presence of VOC's and oil and grease/petroleum hydrocarbons in soils and sediments, and volatile organics in the storm sewer system and Union Creek at Travis AFB suggest discharge of hazardous substances is taking place; particularly solvents, fuels, and other petroleum by-products. During Phase II field investigations, wash waster was observed on one occasion by WESTON personnel, being discharged directly to the storm sewer. It is not known if this is a common or recurring condition. Therefore, it is recommended that all discharge of wash waters and nonaqueous substances directly to the soils or storm sewer system be curtailed, and these solutions be routed to the appropriate sewer system for treatment.

- The shallow water table aquifer has been shown to be contaminated with volatile organics, pesticides, herbicides, and inorganic compounds. Further sampling and analyses are recommended.

- Of the analytes sampled in Stage 1, TOC and phenols were found at or near the detection limit. Furthermore, TOC exhibited little correlation with other organic compounds and, therefore, was of little use in data interpretation. It is recommended that these parameters be dropped from future sampling and analytical protocols associated with site investigations at Travis AFB. Instead, it is recommended that VOC analysis become the principal analytical tool for investigation. At sites thought to be contributing a significant load of inorganics (sanitary landfills) to groundwater, it is recommended that boron be added to the sampling and analytical protocol. In addition, new

monitoring wells should be installed to intercept any floating hydrocarbons. The existing monitoring wells were designed and installed to intercept floating hydrocarbons. Due to perched and semi-confined groundwater, the water levels in most wells rose above the top of the screen, therefore, floating hydrocarbons may not be detected. Samples from these new wells should be submitted for petroleum hydrocarbon identification analysis. This analysis uses capillary gas chromatograph methods to "fingerprint" the product, which can then be compared to samples of known product for identification purposes.

ES.4.2 Site-Specific Recommendations

Specific recommendations for the 12 sites investigated are summarized in Table ES-2. All new and existing locations should be sampled for the analytes recommended following EPA protocols. New wells should be constructed of 4-inch diameter PVC screen and PVC riser pipe in order to better determine the presence of floating hydrocarbons on the water table.

The STPZ is the site of most immediate concern at Travis AFB because it poses the most direct potential threat to drinking water supplies. Contamination associated with the Sewage Treatment Plant has been fairly well defined within the Base boundaries on the basis of current information. Due to the evidence of potential off-Base migration of nitrates, a potential health problem may exist. Further investigation, including sampling of off-Base wells, is required to positively identify the source and evaluate the extent and magnitude of groundwater contamination.

In addition, the presence of volatiles, particularly TCE, in the storm sewer system poses a potential threat to Union Creek. An intensive investigation, including additional monitoring points in the storm sewer and a survey of shops disposing into the storm sewer, is recommended. The investigation of the SSZ should focus on identifying the location, nature, and present status of the source(s) of contamination.

Table ES-2

Summary of Investigation Recommendations

	Existing Monitoring Wells	Recommended New Monitoring Wells	Recommended New Surface-Water Sampling Points	Recommended Analytes in Water	Recommended Additional Field Activities
Storm Sewer Zone					
FTA-1	MW-101	--		VOA	
Oil Spill Area	MW-102, MW-103	2		Petroleum, hydrocarbons, VOA	
Solvent Spill Area	MW-104 MW-105 MW-106	2		Petroleum, hydrocarbons, VOA	
Sewer Right-of-Way	MW-107 through MW-112	--	All storm drains in contaminated zone.	Petroleum, hydrocarbons, VOA, base/ neutrals, acids	Equip storm drains with flow weirs.
Landfill No. 3	MW-113 MW-114 MW-115	--		Pesticides/ herbicides, VOA	
JP-4 Spill Site	MW-116	1		Petroleum, hydrocarbons, VOA	
FTA-4	MW-117 through MW-120			Petroleum, hydrocarbons, VOA	
Sewage Treatment Plant Zone	MW-121 through MW-124	--		VOA, potability factors, pesticides/herbicides, boron, metals	Off-Base well sampling.

Table ES-2
(continued)

	Existing Monitoring Wells	Recommended New Monitoring Wells	Recommended New Surface-Water Sampling Points	Recommended Analytes in Water	Recommended Additional Field Activities
North Landfill Zone					
Landfill No. 1	MW-130	--		VOA	
Landfill No. 2	MW-125 through MW-129	--		VOA, potability factors, boron, metals	
FTA-2	MW-133 MW-134	--		Petroleum hydrocarbons, VOA	
FTA-3	MW-131 MW-132	2		Petroleum hydrocarbons, VOA	
Off-Base	---	1		VOA, potability factors, boron, metals, pesticides/herbicides	Install one well off-Base and upgradient for background concentrations.

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SECTION 1

INTRODUCTION

1.1 INSTALLATION RESTORATION PROGRAM

In 1976, the Department of Defense (DOD) devised a comprehensive Installation Restoration Program (IRP). The purpose of the IRP is to assess and control migration of environmental contamination that may have resulted from past operations and disposal practices on DOD facilities, and probable migration of hazardous contaminants. In response to the Resource Conservation and Recovery Act of 1976 (RCRA), and in anticipation of the Comprehensive Environmental Response Compensation and Liability Act of 1980 (CERCLA, or "Superfund"), the DOD issued a Defense Environmental Quality Program Policy Memorandum (DEQPPM) dated June 1980 (DEQPPM 80-6), requiring identification of past hazardous waste disposal sites on DOD agency installations. The U.S. Air Force implemented DEQPPM 80-6 by message in December 1980. The program was revised by DEQPPM 81-5 (11 December 1981), which reissued and amplified all previous directives and memoranda on the IRP. The Air Force implemented DEQPPM 81-5 by message on 21 January 1982. The Installation Restoration Program has been developed as a four-phase program, as follows:

- Phase I -- Problem Identification/Records Search
- Phase II -- Problem Confirmation and Quantification
- Phase III -- Technology Base Development
- Phase IV -- Corrective Action

The Phase II Problem Confirmation, Stage 1, portion of the IRP effort at Travis Air Force Base is described in this report. Definitions of the terms and acronyms used in this report appear in Appendix A.

1.2 PROGRAM HISTORY AT TRAVIS AIR FORCE BASE

Roy F. Weston, Inc. (WESTON) has been retained by the U.S. Air Force Occupational and Environmental Health Laboratory (OEHL), under Contract F33615-84-D-4400, to provide general engineering, hydrogeological, and analytical services. The Phase I,

Problem Identification/Records Search, for Travis Air Force Base (TAFB) was accomplished by Engineering Science, Inc. (ESI) in April 1983, and their final report was dated August 1983. In response to the findings contained in the ESI Phase I final report, the OEHL issued Task Order 0033 to WESTON, directing that a presurvey be conducted at TAFB. The purpose of this presurvey was to obtain sufficient information to develop a work scope and cost estimate for conducting a full Phase II Problem Confirmation and Quantification Study at TAFB.

The presurvey report for TAFB was submitted by WESTON in March 1984. Following modification of the scope of work, Task Order 0004, dated 20 September 1984, was issued, which authorized a Phase II, Stage 1, study for six areas or zones (including 12 sites) at TAFB, and one zone at the Point Arena Air Force Station (PAFS). Task Order 0004 was further modified and Task Order 000401 was issued, dated 18 March 1984. The modified Task Order required that the Point Arena Air Force Station (PAAFS) investigations be discussed in a separate self-standing report, and therefore, PAFS will not be discussed further in this report.

A copy of the formal Task Order and the formally modified Task Order are included in Appendices B and C, respectively.

On 12 October and 15 October 1984 WESTON met with representatives of Point Arena Air Force Station, and the Bioenvironmental and Civil Engineering Departments of Travis Air Force Base, and one of the drilling subcontractors, Stang Hydronics, Inc., to review the goals of the investigation, review drilling procedures and locations, and establish the field schedule. Monitoring well construction commenced at TAFB on 10 December 1984 and was completed by 21 January 1985. Groundwater and surface-water sampling was conducted in March and May 1985.

1.3 BASE PROFILE

Travis Air Force Base (TAFB) occupies approximately 5,025 acres of land in Solano County, California. The Base is located approximately 3 miles west of the City of Fairfield, and is midway between San Francisco and Sacramento. The area surrounding the Base is dominated by agricultural and livestock activities. Figures 1-1 and 1-2 are index maps showing the location of TAFB.

A number of annexes (Table 1-1) are under the jurisidiction of TAFB, and were included in the Phase I study. Only the Point Arena Air Force Station was included in Phase II investigations and, as stated earlier, that investigation will be included in a separate, self-standing report.

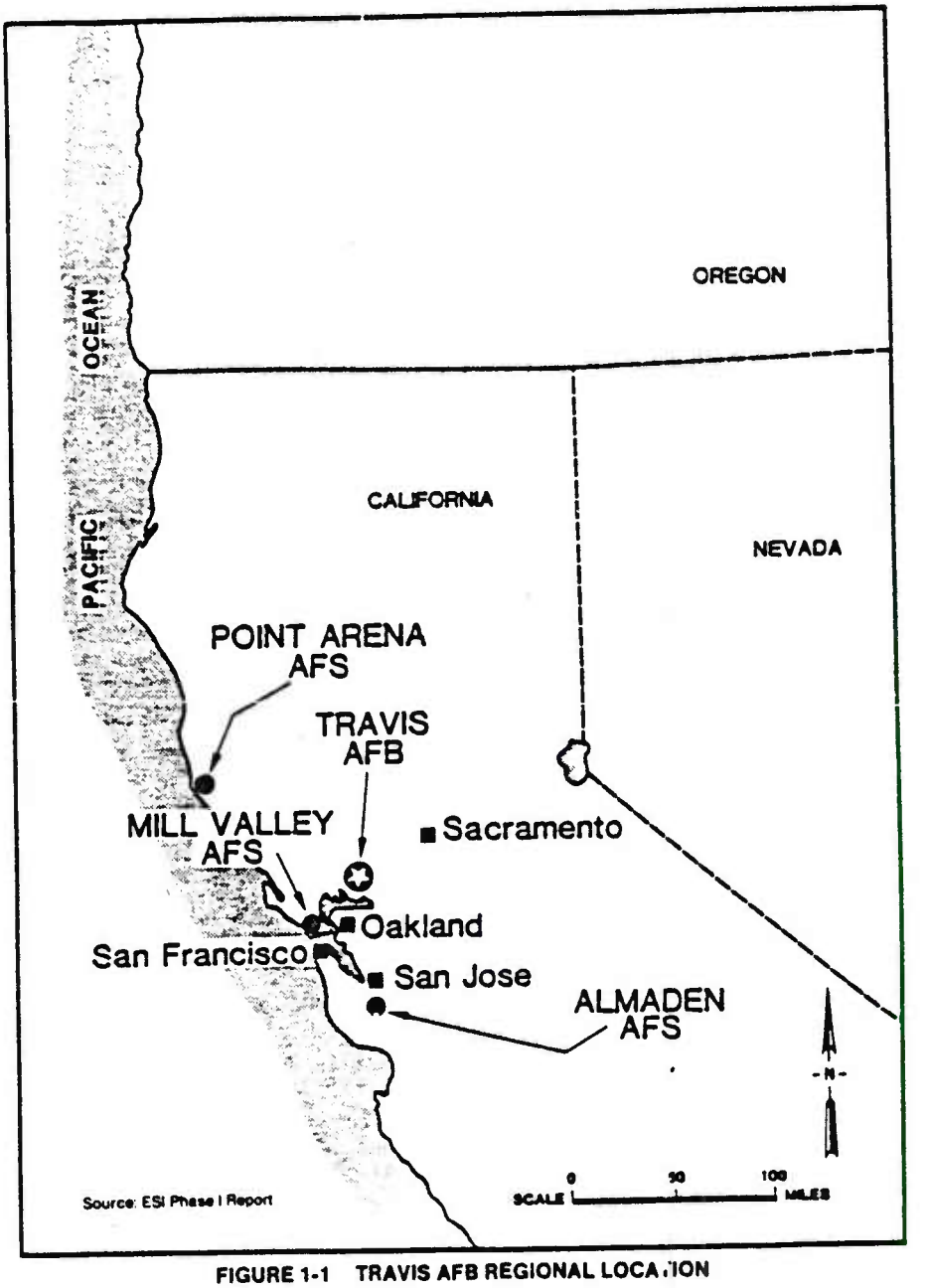

FIGURE 1-1 TRAVIS AFB REGIONAL LOCATION

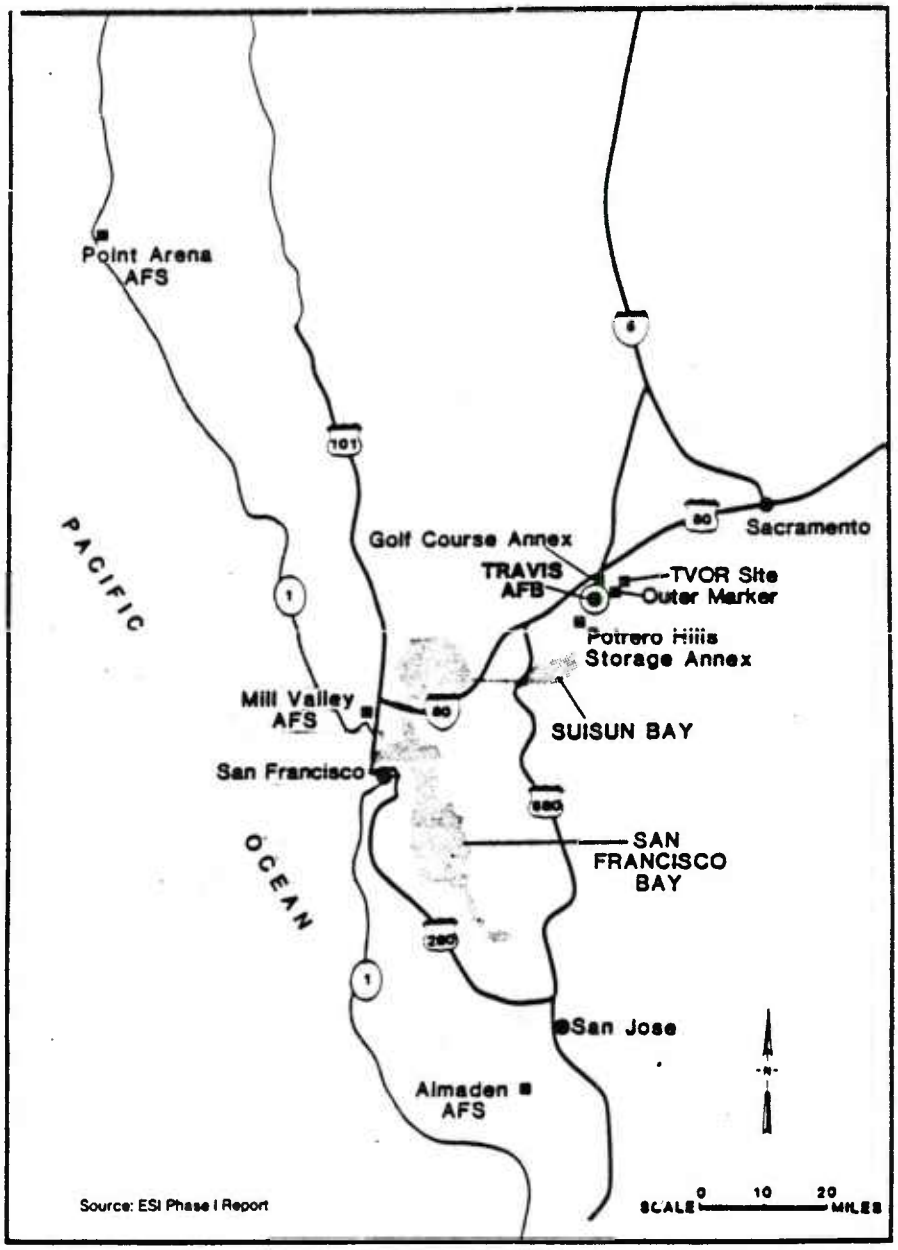

FIGURE 1-2 TRAVIS AFB AREA LOCATIONS

Table 1-1

Travis Air Force Base Annexes

Annex	Size	Use
Golf course annex	206 acres	Golf course and well-field for Base.
Outer marker and TVOR site	316 acres	Navigational aids.
Potrero Hills storage annex	25 acres	Leased to Explosive Technology. Formerly TAFB Defense Area Nike Battery 53.
Almaden Air Force Station	119 acres	Caretaker status. Formerly a long-range radar installation.
Mill Valley Air Force Station	106 acres	Caretaker status. Formerly a radar surveillance center.
Point Arena Air Force Station	81 acres	Long-range radar station.

Travis Air Force Base began as an isolated airstrip with a few temporary buildings in May 1943 as the Fairfield-Suisun Army Base. Shortly after initial activation, the Base was expanded and its primary mission became the ferrying and servicing of tactical aircraft from California to the Pacific war zones. The Base became the West Coast's largest aerial port by 1945, and was actively involved in airlifting troops and supplies to occupied Korea and Japan, and in processing returning troops. In April 1951, the Base name was officially changed to Travis Air Force Base.

The Military Air Transport Services (MATS) assumed jurisdiction of the Base in 1948. Shortly thereafter, from 1949 to 1958, control of the Base was under the Strategic Air Command (SAC), and the Base served as home for SAC bombers, such as the B-29, B-36, and eventually the B-52. During this period, runways were added and widened, new hangers were constructed, and permanent living quarters were established.

MATS resumed control of the Base in 1958, and the Base became the headquarters for MATS' Western Transport Air Force. In 1962, the C-135 and KC-135 stratotanker arrived at TAFB. These aircraft were used at the Base by the SAC 307th Air Refueling Group until late 1983.

In the early 1960's MATS was renamed the Military Airlift Command (MAC). The 60th Military Airlift Wing became the host unit at that time.

Travis AFB was the principal aerial port for troops and supplies bound for Southeast Asia during the Vietnam era. Presently, TAFB is the largest and busiest base in MAC, operating one-half of MAC's C-5 Galaxy force and one-sixth of the C-141 Starlifter force.

The present host organization at TAFB is the 60th Military Airlift Wing (MAW) whose primary mission is to provide global strategic airlift support. The Wing is also responsible for operating TAFB and providing adequate support to a large number of tenant units. Table 1-2 lists the various tenant units.

Current and past Air Force activities at TAFB in support of operational and training missions have resulted in the occurrence on the Base of several waste utilization and disposal sites of potential concern. Table 1-3 contains a list of all sites of potential concern that received priority rankings during Phase I. The priority rankings were determined by Engineering Science using the Hazard Assessment Rating Method (HARM).

Table 1-2

Travis Air Force Base Tenants

Tenants
Air Force Audit Agency
AFOSI Detachment 1900
AFOSI District 19
American Red Cross
David Grant USAF Medical Center
Armed Forces Courier Service
Audiovisual Service Center
Civil Air Patrol, Squadron 22
Defense Investigative Services
Defense Reutilization and Marketing Office
DOD Wage Fixing Authority
Military Air Traffic Coordinator Unit (MATCU)
Military Personnel Transportation Assistance Office
Navy Construction Office (ROICC)
Navy Quick Trans CPE Cargo
OL-K AFESC/CEMIRT
OL OH AF Commissary/FCS
Operating Loc L Hq MAC
U.S. Customs
U.S. Department of Agriculture
U.S. Postal Service
USAF Trial Judiciary 5th Circuit
17th Weather Squadron
Detachment 2, 17th Weather Squadron
22nd Air Force
349th Military Airlift Wing
Detachment 4, 375th Aeromedical Airlift Wing
Field Training Detachment 524
Detachment 2, 1600th Management Engineering Squadron (MACMET)
1901st Information Systems Group
3566th USAF Recruiting Squadron
T 37 ACE Detachment
USAF Scouting Liaison Office
2604 Reserve Recruiting Squadron

Table 1-3

Priority Ranking of Potential Contamination Sources from Phase I Report

Site No.	Site Name	Overall Total Score
1	Fire Protection Training Area No. 4	65
2	Fire Protection Training Area No. 3	63
3	Disposal Site No. 1 (Point Arena)	58
4	Landfill No. 2	53
5	Solvent spillage	53
6	Landfill No. 3	51
7	Fire Protection Training Area No. 1	49
8	Fire Protection Training Area No. 2	48
9	Disposal Site No. 3 (Point Arena)	47
10	JP-4 spill -- 1978	44
11	Oil spillage	43
12	Sewage treatment plant (STP) sludge disposal areas	40
13	Sewage treatment plant (STP) abandoned oxidation ponds	38
14	Radioactive Waste Burial Site No. 2 (RB-2)	36
15	Landfill No. 1	35
16	Radioactive Waste Burial Site No. 1 (RB-1)	4

Task Order 0033 added the storm sewers contaminated with trichloroethene (TCE) to the list of priority rankings. At the presurvey meeting, the following was decided:

- Elevate the storm sewer problem to the highest priority at TAFB.
- Add Fire Training Area No. 1 (site 7 from Table 1-3) and the Solvent Spill Area (site 5 from Table 1) to the evaluation of the TCE-contaminated storm sewers.
- Add Landfill No. 1 (site 15 from Table 1-3) to Landfill No. 2 in a single zone evaluation.

The final list of sites requiring Phase II evaluation, and the final priority rankings are shown in Table 1-4. The sites are located throughout the Base as depicted in Figure 1-3.

1.3.1 History and Description of the Storm Sewer Zone (SSZ)

Site 1, the Storm Sewer Zone, encompasses four separate areas: the storm sewers themselves, the Solvent Spillage Area, the Oil Spillage Area, and Fire Training Area No. 1.

1.3.1.1 History and Description of the Storm Sewer Drainage System (Sewer Right-of-Way)

Throughout the history of the Base, miscellaneous chemical wastes generated from Base shops have been discharged into the storm sewer and surface drainage systems (Figure 1-4). Beginning in April 1983 and ending in March 1984 an investigation was conducted to determine the potential sources of trichloroethene detected in Union Creek. Various stormwater drains across the Base were sampled and the samples analyzed. Concentrations of TCE found in water samples taken from the stormwater drains ranged from not detected to 0.570 mg/L. This highest concentration of 0.570 mg/L exceeds the State Action Level of 0.005 mg/L. The investigation concluded that there was probably more than one source of the TCE found in the storm sewers and in Union Creek.

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Table 1-4

Final List of Sites
for Phase II Evaluation

Final Site No.	Site Description and Components	HARM Score
1.	Storm Sewer Zone	Unranked
	a. Storm sewers (old site 17) b. Solvent spillage area (site 5) c. Oil spillage area (site 11) d. Fire Training Area No. 1 (site 7)	
2.	Fire Training Area No. 4 (site 1)	65
3.	North Landfill Area	63
	a. Fire Training Area No. 3 (site 2) b. Landfill No. 2 (site 4) c. Fire Training Area No. 2 (site 8) d. Landfill No. 1 (site 15)	
4.	Point Arena AFS Zone	58
	a. Disposal Site No. 1 (site 3) b. Disposal Site No. 3 (site 9)	
5.	Landfill No. 3 (site 6)	51
6.	JP-4 Spill, 1978 (site 10)	44
7.	Sewage Treatment Plant Zone	40
	a. Sewage treatment plant sludge disposal (site 12) b. Sewage treatment plant oxidation ponds (site 13)	
8.	Radioactive Waste Burial Site No. 2 (site 14)	36

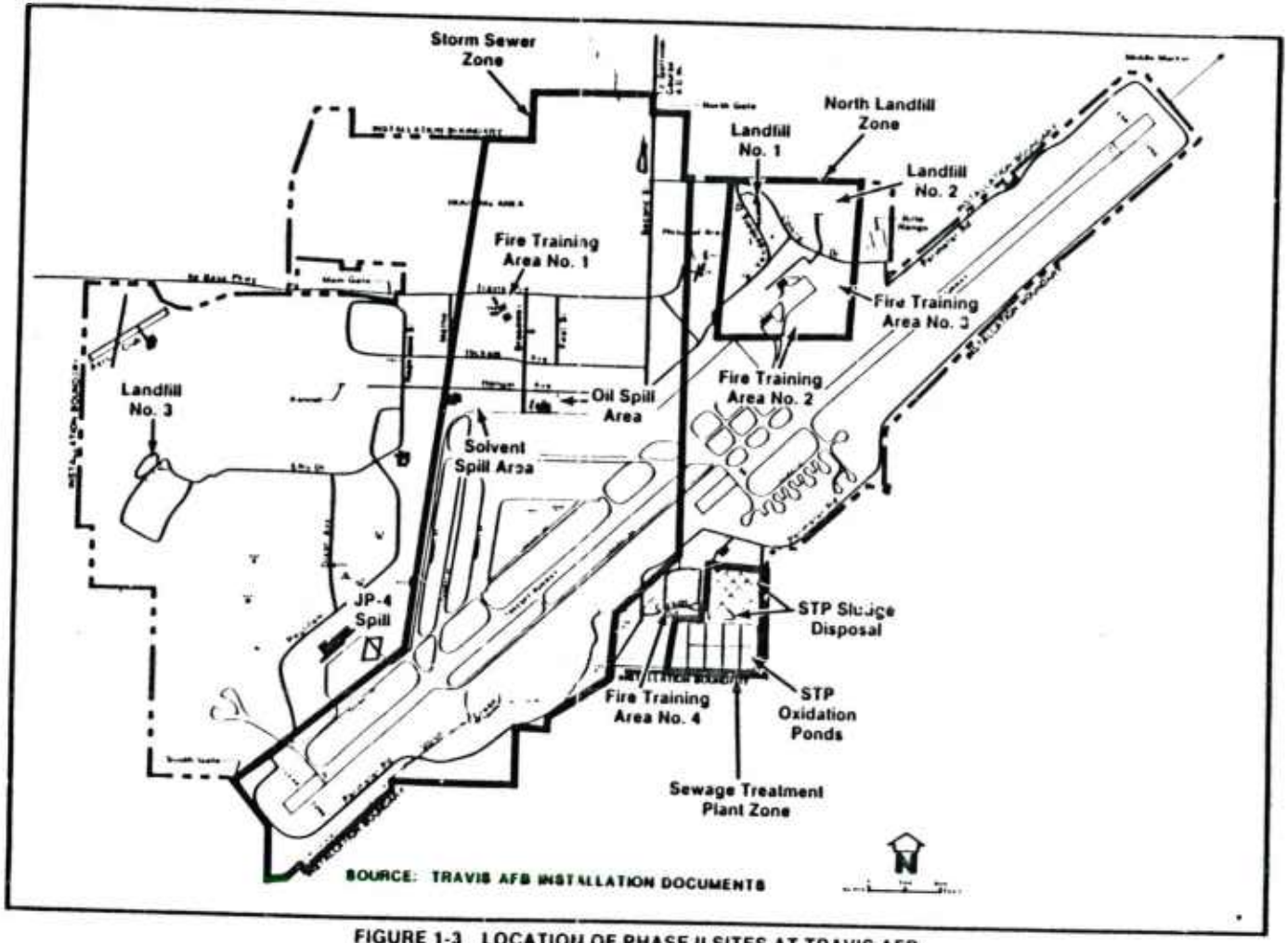


FIGURE 1-3 LOCATION OF PHASE II SITES AT TRAVIS AFB

1.3.1.2 History and Description of the Solvent Spillage Area

In the area located east of Building 550 (Figure 1-4), spillage of solvents has occurred. This area was used for stripping of radomes (aircraft nose pieces). The spillage was detected in June 1981. The length of time that leakage occurred is not known. Aporoximately 100 to 150 gallons/month of methylethyl ketone (MEK), toluene, or tetraethylene glycol dimethyl ether may have leaked from, or splashed out of, a work tray during the stripping process. The chemicals either evaporated or soaked into the ground. Review of aerial photos and the site visit revealed no evidence of the spillage.

1.3.1.3 History and Description of the Oil Spillage Area

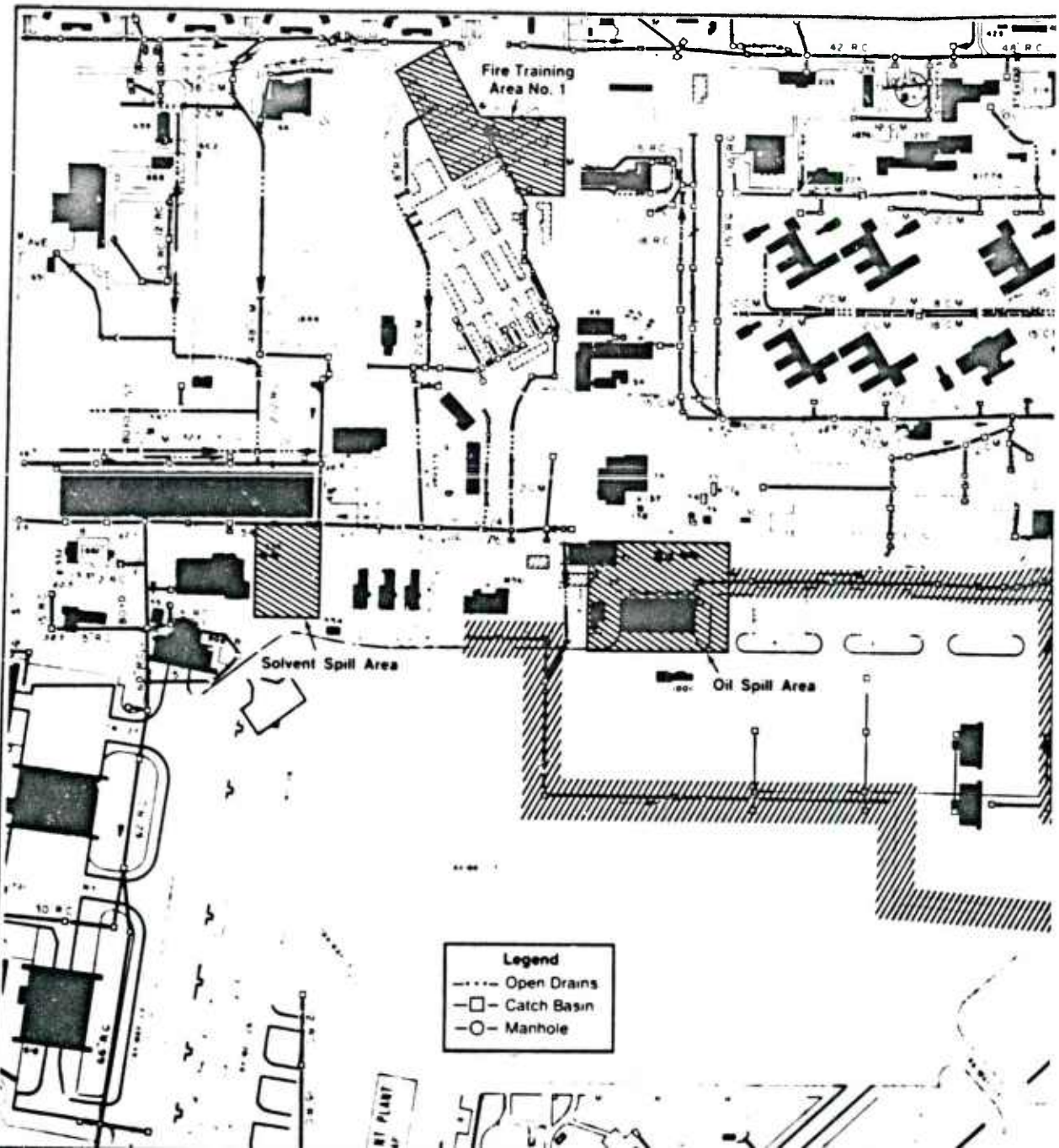
The area behind Building 16 (Figure 1-4) was the site of past oil spillage. According to the Phase I report, the area was apparently used to discard waste oil onto the soil. Review of aerial photos and observations during the site visit revealed no evidence of oil staining on the soils. The oil residues observed during the Phase I survey may have been washed away or soaked into the ground in the intervening period between the Phase I and Phase II investigations.

1.3.1.4 History and Description of Fire Training Area No. 1 (FTA-1)

The area located along Travis Avenue and Airmen Drive, now occupied by barracks (Buildings 103 through 109), is the first place known to have been used for fire protection training exercises (Figure 1-4). The site was utilized from 1943 until 1950 when it was moved to construct the existing barracks. Fuels used for the exercises consisted of waste fuel, oil, solvents, and other combustible wastes. Water was used as the primary extinguishing agent.

1.3.2 History and Description of Fire Training Area No. 4 (FTA-4)

Beginning in 1962 and continuing to the present, fire training exercises have been conducted in an area on the east side of the Base near the old Sewage Treatment Plant (Figure 1-5). From 1962 until the early 1970's, waste fuel, oils, and solvents were used to fuel the training fires. The wastes were delivered


Fire Training
Area No. 1
Solvent Spill Area
Oil Spill Area
Legend
Open Drains
Catch Basin
Manhole

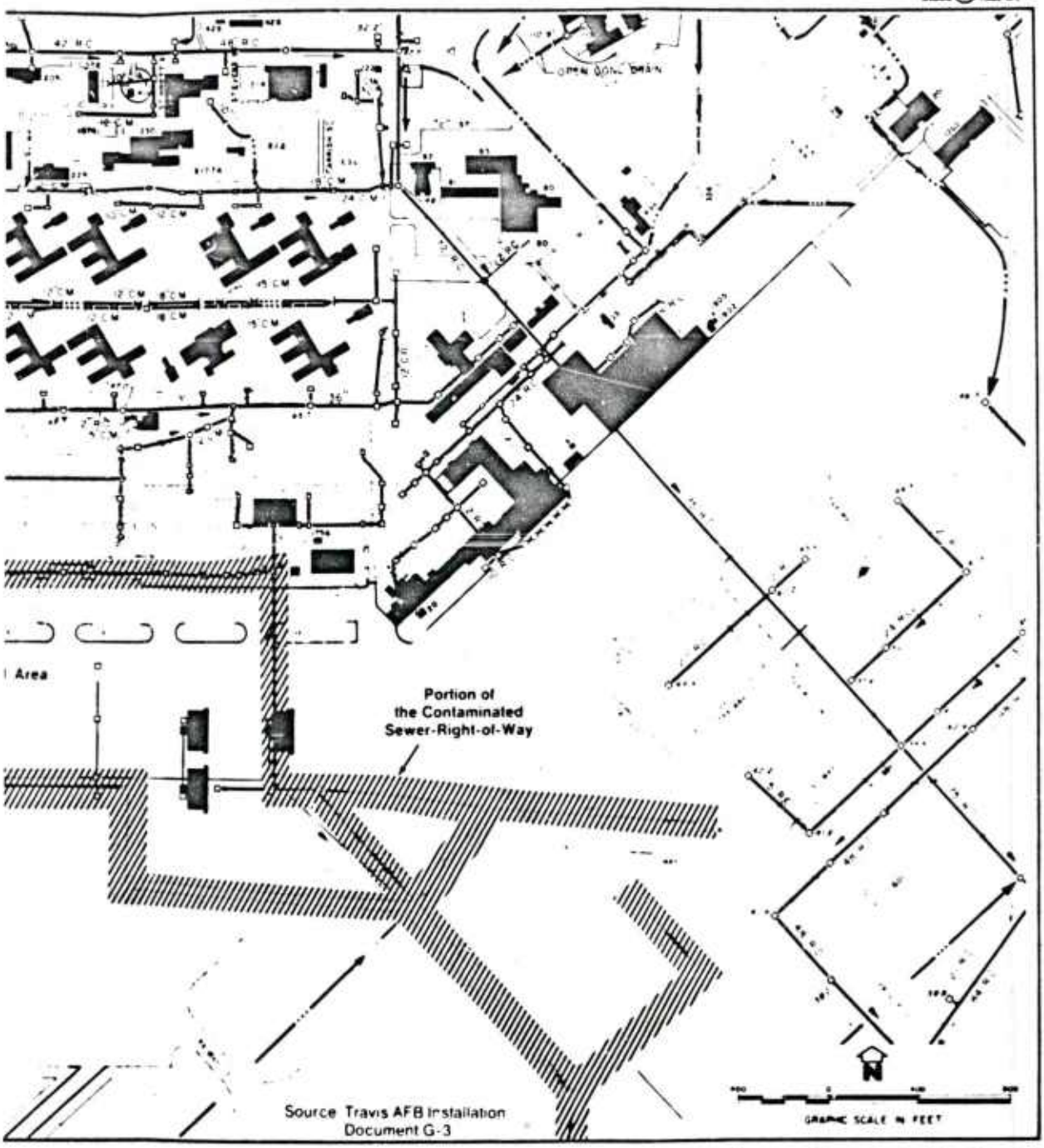


FIGURE 1-4 LOCATION OF AREAS IN THE STORM SEWER ZONE

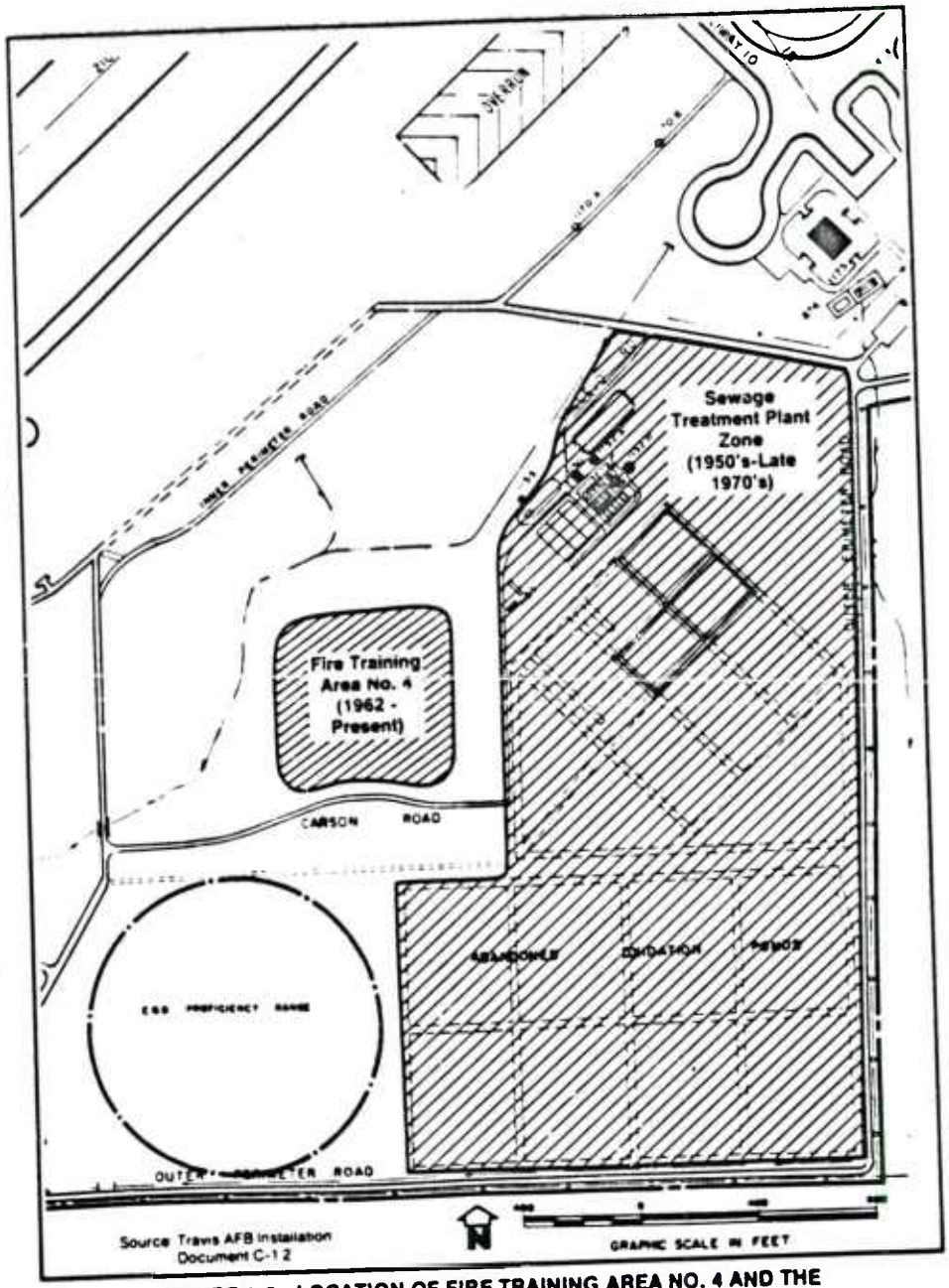


FIGURE 1-5 LOCATION OF FIRE TRAINING AREA NO. 4 AND THE SEWAGE TREATMENT PLANT ZONE

to the site in 55-gallon drums. Since the early 1970's only contaminated fuels (e.g., JP-4) have been used during the training exercises. In about 1976, an above-ground storage tank was installed at FTA-4 to hold the waste fuels. The extinguishing agents used at the site were aqueous film forming foam (AFFF), protein foam, and water. The site has no berms or dikes to contain runoff, and the surface runoff flows to Union Creek. Observations during the site visit revealed general wastes (wood, pallets, and metal) discarded in this area. During the Phase II investigations, the site was cleared of debris and "No Dumping" signs were posted. Some dead vegetation was evident in areas bordering the site and in drainage swales.

1.3.3 History and Description of the North Landfill Zone (NLZ)

The North Landfill Zone is located in the northeast portion of the Base and is comprised of four separate areas: Landfill No. 1, Landfill No. 2, Fire Training Area No. 2, and Fire Training Area No. 3 (Figure 1-6).

1.3.3.1 History and Description of Landfill No. 1 (LF-1)

This landfill is suspected of having been first used when the Base was activated in 1942 (Figure 1-6). Landfill No. 1 was located in an excavated area, and operated as a fill and burn landfill. Burning usually occurred on a daily basis or at least several times per week. General Base refuse was disposed of at the site and some industrial wastes may have also been disposed of there. The landfill was closed during the mid-1950's, and the area covered and compacted; it now supports a trailer park.

1.3.3.2 History and Description of Landfill No. 2 (LF-2)

Landfill No. 2 is located directly east of Landfill No. 1 (Figure 1-6). The landfill began operation in the late 1950's, with the trench and fill method being utilized. The trench dimensions were estimated from aerial photos to be 400 to 500 feet long, 40 feet wide, and 10 to 15 feet deep. Observations during the site visit revealed uneven subsidence across the site, and a poor cover. Ponded water was observed in depressed areas.

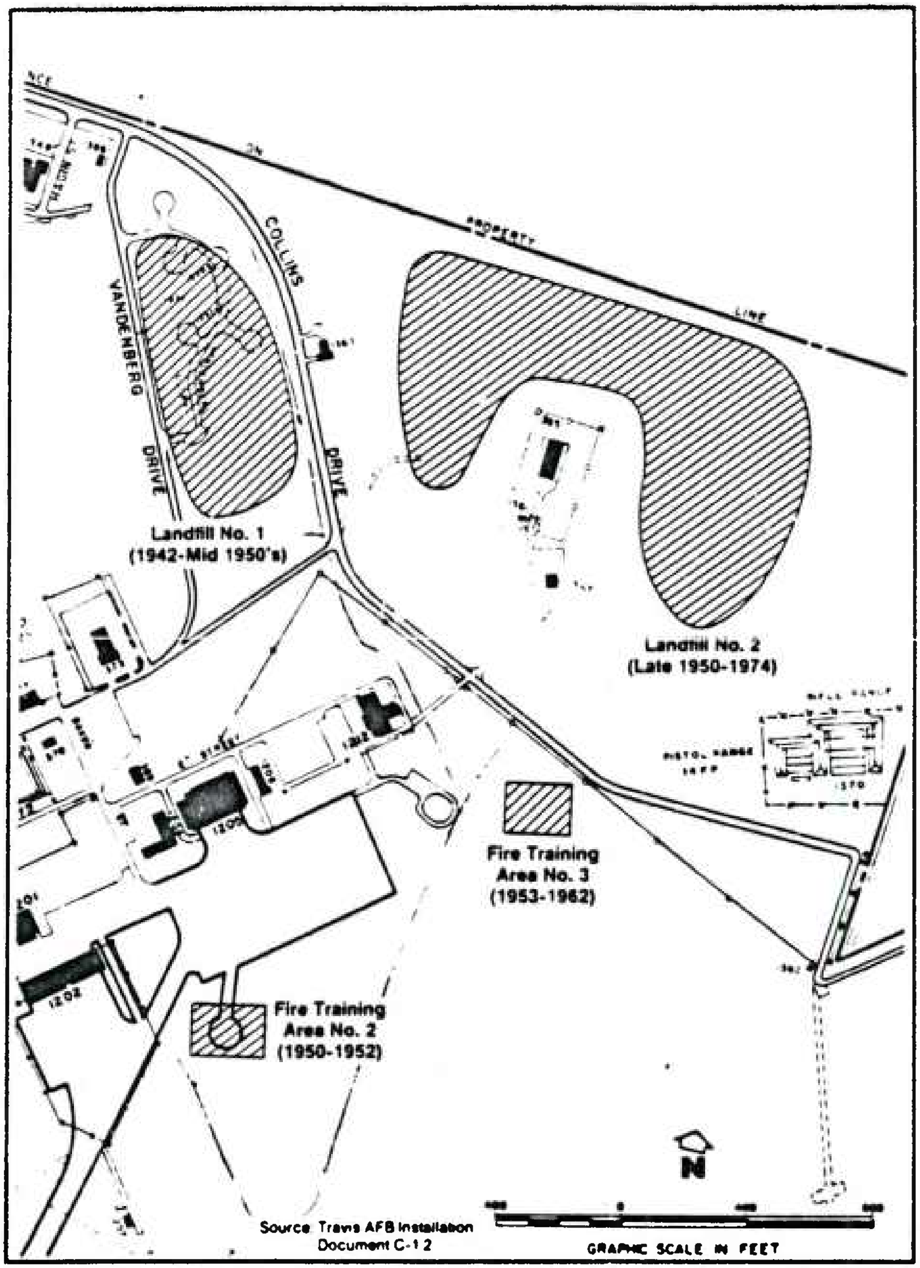


FIGURE 1-6 LOCATION OF AREAS IN THE NORTH LANDFILL ZONE

The landfill received general refuse and possibly minor amounts of industrial waste. Fuel sludge from tank cleaning operations were reported to have been disposed of in Landfill No. 2. No routine burning operations were conducted at the landfill. The wastes disposed of were compacted and covered twice per week. The landfill was closed around 1974 and covered with approximately 3 feet of clayey soils.

1.3.3.3 History and Description of Fire Training Area No. 2 (FTA-2)

Review of aerial photos revealed FTA-2 in an area between Building 1205 and the runway (Figure 1-6). The area is now covered by a concrete pad. The area was used from 1950 until 1952. Waste fuels, oils, and solvents were burned in training exercises in this area. The extinguishing agents used were foam and water.

1.3.3.4 History and Description of Fire Training Area No. 3 (FTA-3)

In 1953, FTA-3 was established approximately 1,000 feet north of FTA-2 (Figure 1-6). Approximately 20 to 30 55-gallon drums of waste fuels, oils, and solvents were delivered in bowsers and drums to the site per week. Burning typically occurred on the weekends. The extinguishing agents used were protein foam and water. Utilizing aerial photos, the circular site was located and stained soils were observed during the site visit. The area is presently graded and covered with native grasses.

1.3.4 History and Description of Landfill No. 3 (LF-3)

Landfill No 3 is located within the Weapons Storage Area in the western portion of the Base (Figure 1-7). The area was used between 1972 and 1977 to dispose of crushed and rinsed pesticide containers and bags. The rinsate was also disposed of in the landfill. The materials were buried in trenches 120 feet long, 3 feet wide, and 6 feet deep. During the site visit, the trenches were evident as subsidence areas. Approximately 30 cubic yards of materials were buried in the landfill.

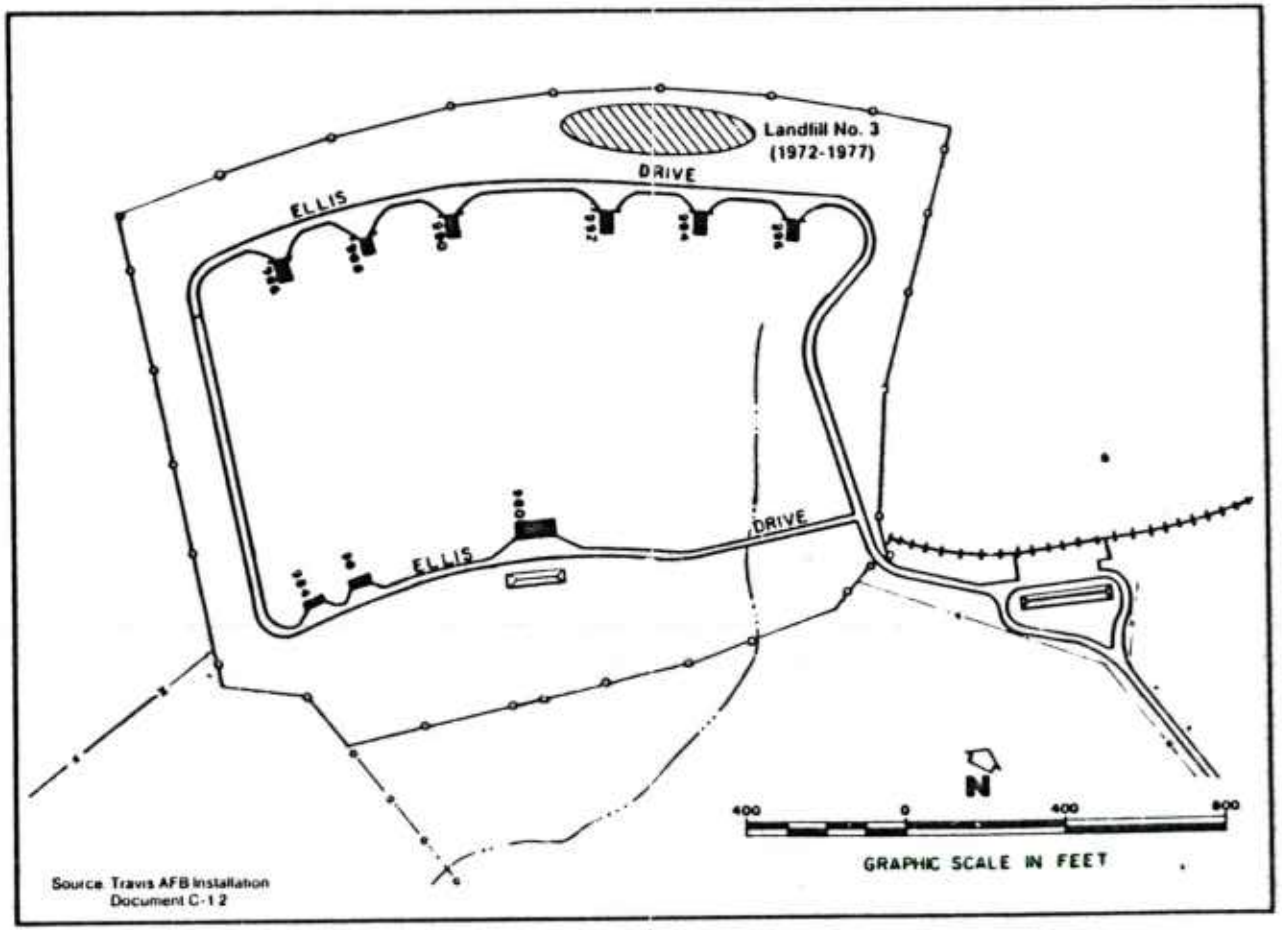


FIGURE 1-7 LOCATION OF LANDFILL NO. 3

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1.3.5 History and Descriotion of the JP-4 Spill Area (JP-4)

In May 1978, a major JP-4 spill occurred at the fuel tank located east of Building 977 (Figure 1-8). Approximately 15,000 gallons of fuel spilled into a drainage ditch that connected to Union Creek. The spill was reported to have killed the aquatic wildlife in a 2-mile area along Union Creek. Vacuum pumps, dams, and absorbent materials were used to clean up the spilled fuel. During the site visit no evidence of the spill was observed.

1.3.6 History and Description of the Sewage Treatment Plant Zone (STPZ)

From the early 1950's until the late 1970's Travis AFB operated a Sewage Treatment Plant. The old plant is located in the southeast portion of the Base (Figure 1-5). The treatment system was comprised of a settling basin, oxidation ponds, and a chlorine contact chamber. The oxidation ponds were lined with clayey soils. The ponds reportedly held water without any apparent losses. Presently, the ponds contain cracks, and have trees and weeds growing in them. The treatment system was used to treat domestic and some industrial wastes from the Base. The treated effluent from the Sewage Treatment Plant was discharged to Union Creek. Sludge from the settling basin was pumped through a digester system. Approximately 100 cubic yards of digested sludge was spread over areas adjacent to the Sewage Treatment Plant annually.

During the late 1970's, TAFB began pumping its domestic wastes to the Fairfield-Suisun Sewer District Treatment Plants. The Sewage Treatment Plant at Travis is no longer in use.

1.4 CONTAMINATION PROFILE

At Travis AFB most of the products and wastes potentially containing hazardous substances have been associated with technical and routine Base maintenance activities. The primary products and wastes of concern are hydrocarbons, solvents, and pesticides and herbicides. Fuel sludges and treatment plant sludges were also generated in the past and are of concern.

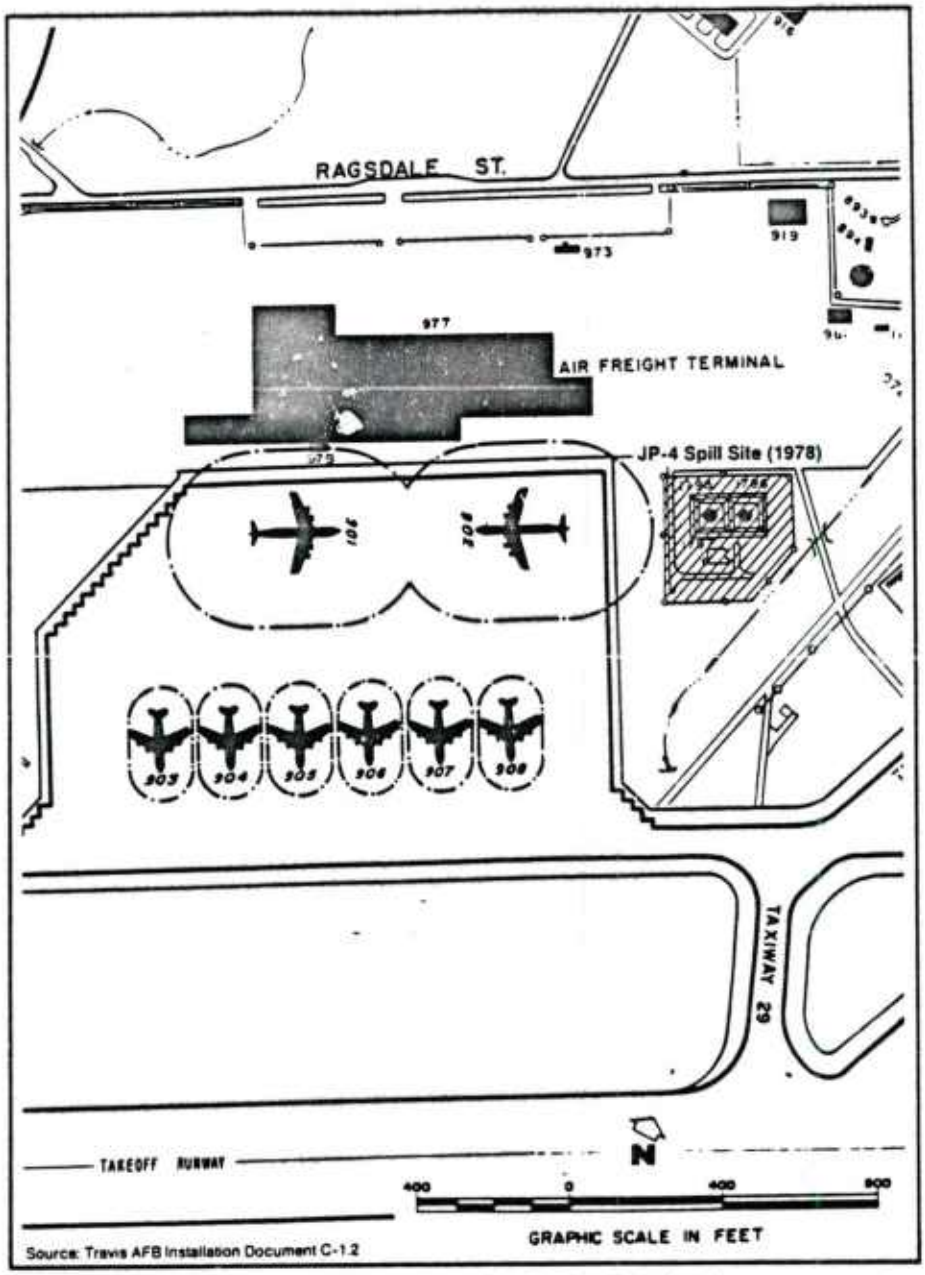

FIGURE 1-8 LOCATION OF THE JP-4 SPILL SITE

Information obtained through interviews with present and past Base personnel, Base records, shop folders, and field observations indicates that the hazardous wastes generated at Travis AFB are, for the most part, properly handled and discarded.

Fuel mixed with waste solvents and oils was utilized for fire training exercises. Presently, only fuel contaminated through routine use is utilized for these exercises. There is a high potential for contamination of shallow groundwater and nearby surface waters with unburned fuels and extinguishing agents. The general refuse, pesticides, and possible industrial wastes that were disposed of in the landfill areas pose a moderate potential for contamination from leachate seepage to groundwater. The inactive oxidation ponds and sludge disposal areas pose a low potential for contamination to groundwater and nearby surface waters. In addition, solvents, oils, and fuels have entered the soil from spills and may also contribute to the introduction of contaminants to the ground and surface waters. Surface drainage and disposal of wastes to the storm sewer system pose a threat to groundwater and particularly to surface waters.

Based on the Travis AFB Phase I Records Search and the Phase II presurvey report, the key chemical parameters of potential concern are the following:

- Volatile organic compounds (VOC or purgeables).
- Pesticides and herbicides.
- Oil and grease/petroleum hydrocarbons.
- Phenols.
- Total organic carbon (TOC).
- Heavy metals.

The potential contaminants and associated analytes for each site are presented in Table 1-5.

1.5 PROJECT TEAM

The Phase II, Stage 1, Confirmation Study at Travis AFB was conducted by and under the auspices of staff personnel of Roy F. Weston, Inc., and was managed through WESTON's home office in West Chester, Pennsylvania. The following personnel served lead functions in performance of this project:

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Table 1-5

Summary of Analytical Protocol
Travis AFB

Site	Potential Contaminants	Medium	Analytes
Storm Sewer Zone	Solvents, waste oils, trichloroethene	Water	Purgeables, base/ neutrals, acids, oil and grease, TOC, phenols, potability factors[1]
		Soil/sediment	Oil and grease, VOA
Fire Training Area No. 4	Waste fuels and oils, solvents	Water	Purgeables, base/ neutrals, acids, petroleum hydrocarbons, TOC, phenols, potability factors[1]
		Soil/sediment	Oil and grease, VOA
North Landfill Zone	Industrial chemicals and metals, pesticides, and herbicides	Water	Purgeables, base/ neutrals, acids, TOC, phenols, pesticides, herbicides, petroleum hydrocarbons, metals, potability factors[1]
		Soil	Petroleum hydrocarbons, VOA

[1]Potability factors = Ca, Mg, Na, alkalinity, SO_4, Cl, NO_3, TDS.

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Table 1-5
(continued)

Site	Potential Contaminants	Medium	Analytes
Landfill No. 3	Pesticides and herbicides	Water	Purgeables, base/neutrals, acids, TOC, pesticides, herbicides, metals, potability factors[1]
JP-4 Spill Area	JP-4 fuel	Water	Purgeables, base/neutrals, acids, TOC, petroleum hydrocarbons, potability factors[1]
Sewage Treatment Plant Zone	Industrial chemicals, pesticides, and herbicides	Water	Purgeables, base/neutrals, acids, TOC, phenols, pesticides, herbicides, potability factors[1]
		Sediment	Oil and grease, VOA

[1]Potability factors = Ca, Mg, Na, alkalinity, SO_4, Cl, NO_3, TDS.

Mr. Peter J. Marks, Program Manager - Corporate Vice President; M.S. in Environmental Science; 20 years experience in laboratory analysis and applied environmental sciences.

Dr. Frederick Bopp III, Ph.D., P.G., Department Manager - Ph.D in Geology and Geochemistry; registered Professional Geologist; over 8 years experience in hydrogeology and applied geological sciences.

Ms. Katherine A. Sheedy, P.G., Project Manager - M.S. in Geology; registered Professional Geologist; 10 years experience in hydrogeology, environmental geology, and environmental impact statements.

Mr. Jack E. Dowden, Geotechnical Quality Assurance Officer - M.S. in Hydrogeology; over 5 years experience in hydrogeology and evaluation of subsurface contamination.

Ms. Lisa A. Hamilton, P.G., Project Geologist - B.S. in Geology; registered Professional Geologist; over 5 years experience in hydrogeology and evaluation of subsurface contamination.

Dr. David Ben-Hur, Ph.D., Laboratory Manager - Ph.D in Physical Organic Chemistry; over 20 years experience in environmental sampling and analysis, including 10 years experience in laboratory management.

1.5.1 Subcontracting

The drilling and well installation work on this project was performed by Stang Hydronics, Inc. of Rancho Cordera, California, and Datum Exploration, Inc. of Long Beach, California. The well elevation survey was completed by Larsen, Ohlinger, and Hill (LOH), Architects and Surveyors, of Merced, California.

1.6 FACTORS OF CONCERN

The primary factor of concern at Travis AFB is the potential for contamination of surface waters and groundwater. The potential for contamination of surface waters is high for the following reasons:

- The storm sewer system, which is known to be contaminated with TCE, discharges directly into Union Creek.
- Detectable concentrations of TCE have been found in Union Creek on-Base and migrating off-Base.
- Current practices do not prevent inadvertent disposal of wastes into the storm sewer system.

The potential for groundwater contamination is less than for surface waters due to the following:

- Sampling of off-Base wells by the Solano County Health Department found no detectable volatile organic compounds (Appendix D).
- The soils beneath the site are silty and clayey, enhancing attenuation and adsorption of contaminants.

SECTION 2

ENVIRONMENTAL SETTING

2.1 GEOGRAPHY

Travis Air Force Base is located in the Suisun-Fairfield Basin along the western edge of the Sacramento Valley, within the Great Valley Physiographic Province. To tne north and west of the Suisun-Fairfield Basin are the foothills of the Coast Ranges, and to the east is the Sacramento Valley. The Suisun Marsh is located to the south of the Basin. The marsh is part of the San Francisco Bay estuary system, which directs flow from the Sacramento and San Joaquin Rivers through the Delta and Carquinez Strait for eventual discharge to the Pacific Ocean via the San Francisco Bay. The Suisun-Fairfield Basin is characterized by gently sloping hills to the north stretching into an alluvial plain with a gradational contact southward to the Suisun Marsh (Engineering-Science, 1983).

The climate in the Suisun-Fairfield Basin is characterized by dry, hot summers and moist, cool winters. The average annual temperature is approximately 60°F; the period of record is from the early 1940's to mid-1983. The average annual precipitation is 16.1 inches, of which approximately 95 percent generally falls from October through April, and over 50 percent from December through February. The mean evapotranspiration for the Travis AFB area is 47 inches/year, yielding an average annual net precipitation (actual precipitation minus potential evapotranspiration) of negative 31 inches.

Native soils at Travis AFB consist primarily of silt and clay loams, including Antioch, San Ysidro, Millsap, Solano, and Dibble-Los Osos soils (Figure 2-1). In general, the soils across the Base consist of silts and clays, with some sand, exhibiting low permeabilities, poor drainage characteristics, and shallow water tables (Engineering-Science, 1983).

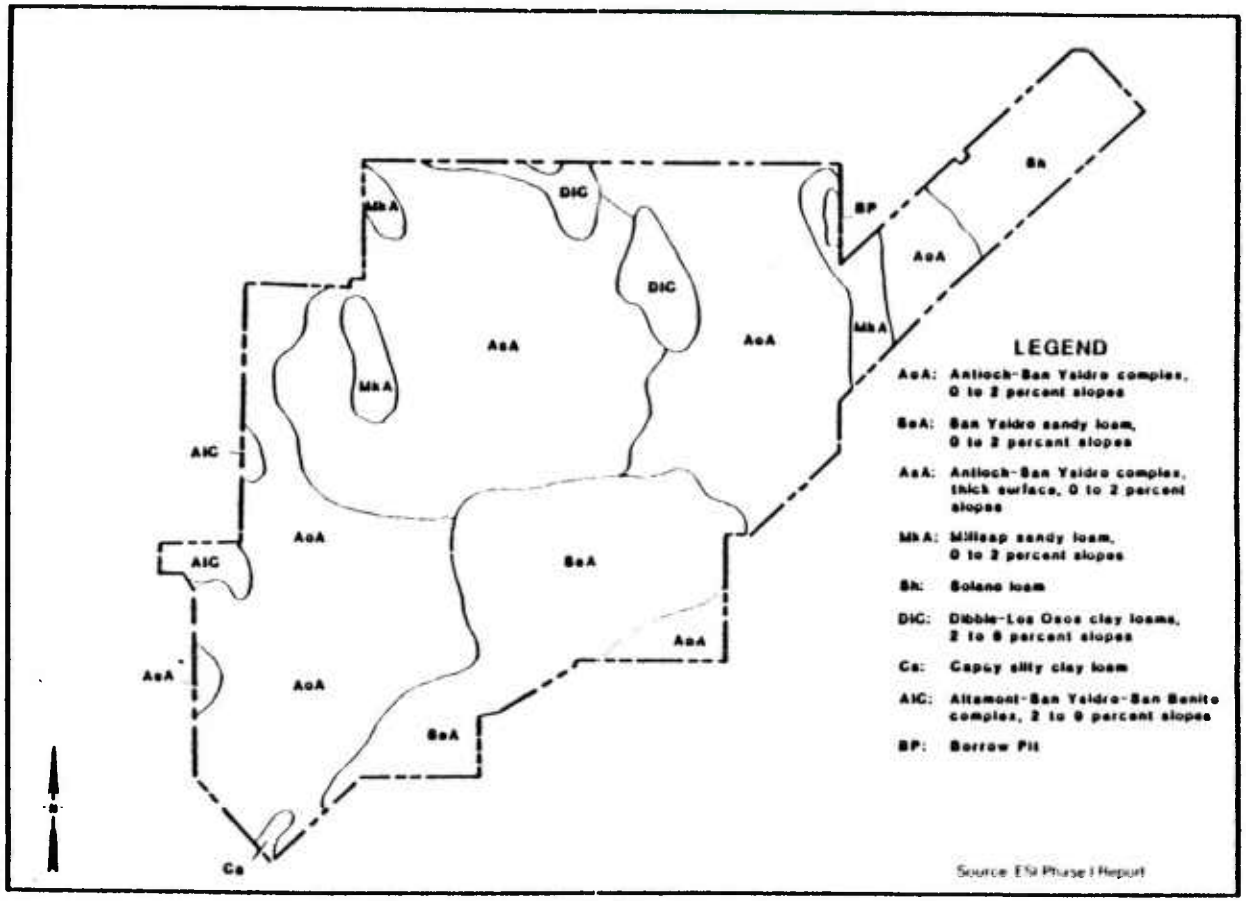

FIGURE 2-1 DISTRIBUTION OF SOIL TYPES AT TRAVIS AFB

2.1.1 Surface Drainage

Surface drainage in the Suisun-Fairfield Basin is generally southward towards the Suisun Marsh and Suisun Bay. Relief at the installation ranges from a high of 100 feet above mean sea level (MSL) at the northern boundary to a low of 20 feet above MSL at the southern boundary. The average slope is 30 feet per mile. Natural drainage features at Travis AFB have been substantially altered by runway construction and the installation of storm drains and perimeter ditches. Surface drainage is now controlled by these ditches and storm sewers. Figure 2-2 depicts the surface drainage across Travis AFB. The northeastern portion of the Base discharges into the Denverton Creek drainage area.

The southern and southeastern portions of the Base (the majority of the Base) drains to Union Creek. Union Creek enters the Base from the north, and is impounded shortly after entering the Base to form the Duck Pond, a recreational pond. The creek is then routed through the Base storm sewers and ditches until it again forms a creek along the southeastern installation boundary (Figure 1-3). The storm sewers discharge into Union Creek at several points along the southeastern boundary. Drainage to the storm sewers and ditches is composed of runoff from the Base streets, runways, and residential and industrial areas.

The water level in Union Creek is heavily influenced by the amount of runoff from the Base. The water level has been observed to rise by 4 to 5 feet in a matter of hours after a heavy rainfall. The flow in Union Creek and Denverton Creek empties into Montezuma Slough in the Suisun Marsh.

2.1.2 Surface-Water Quality

Since 1978, personnel at Travis AFB have collected surface-water samples on a quarterly basis from three locations on the Base. Trichloroethene (TCE) was added to the list of routine parameters analyzed in 1981. Since that time low levels of TCE have been consistently detected where Union Creek leaves the Base. From April 1983 to March 1984 an extensive investigation was conducted by the Air Force to determine the source of TCE. The investigation involved sampling several storm sewer drains located along the storm sewers that discharge to Union Creek. Table 2-1 summarizes the results of these sampling events. TCE and other volatile organics were found in several storm drains, generally in the central portion of the Base. The results indicate that there are potentially several sources of TCE. In addition, the Phase I report states that TCE has not been utilized on Base for several years; therefore, the TCE found in Union Creek and the storm sewers may originate from surface runoff or shallow groundwater discharge.

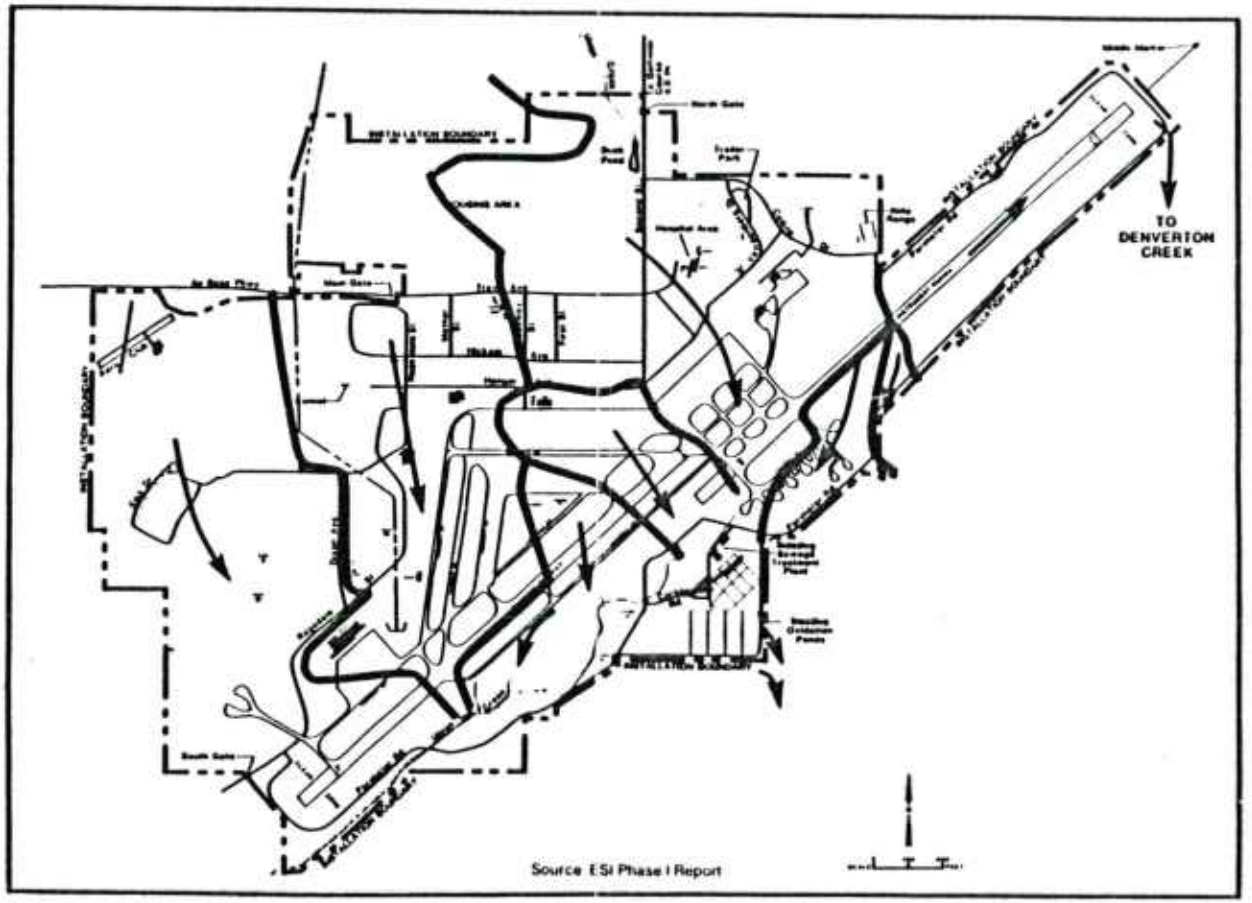

FIGURE 2-2 TRAVIS AFB SURFACE DRAINAGE

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Table 2-1

Results of Storm Sewer USAF Investigation
at Travis AFB

Date	Range of Concentrations (mg/L)				
	Trichloro-ethene	Chloro-benezene	Trans-1, 2-dichloroethane	Tetra-chloroethene	Benzene
19 April 1983	ND-0.0807	--	--	--	--
25 May 1983	ND-0.570	--	--	--	--
12 September 1983	ND-0.449	--	0.041	--	--
19 March 1984	0.015-0.240	0.0065	0.014-0.091	0.0012-0.0044	0.0013

ND - None detected
-- Not registered.

2.2 GEOLOGY

2.2.1 Geological History

The geology of the Suisun-Fairfield Basin is heavily influenced by the geological history of the area. The subsurface materials found in the basin date back to Early Cretaceous time. These sediments were deposited in a shallow marine basin at the site of the present Coast Ranges. The sediments were derived from an old land mass to the west and from an ancestral Sierra Nevada to the east. The deposition of these silts, sands, and clays continued with only slight interruption throughout Paleocene and Eocene time.

In the middle to late Pliocene the Coast Ranges began to form, while the Cretaceous, Paleocene, and Eocene marine sediments, which had become consolidated, were folded and faulted. These sediments became subject to erosion. Later in the Pliocene age the Sonoma volcanics began to cover the western portion of the Suisun-Fairfield Basin, covering some of the eroded sedimentary deposits.

During the Pleistocene age, the Coast Ranges were again elevated, and repeatedly folded and faulted. At the same time, the ancestral San Joaquin and Sacramento Rivers eroded and carved a trough across the rising ranges from the Great Central Valley to the sea.

Throughout the Pleistocene age up to the Recent age, deposition of alluvial, lagoonal, and transitional sediments has taken place in the Suisun-Fairfield Basin. The Suisun Bay and San Francisco Bay came into existence with the rise in sea level and tectonic subsidence during the Late Pleistocene age.

2.2.2 Stratigraphy

Travis AFB is primarily underlain by sediments of Quaternary age (Figure 2-3). The northern portion of the Base is underlain by alluvium (QaL) of Recent age. This alluvium consists of interfingering and irregular lenses of gravels, sands, silts, and clays ranging from 5 to 60 feet thick. The fine-grained materials are dominant.

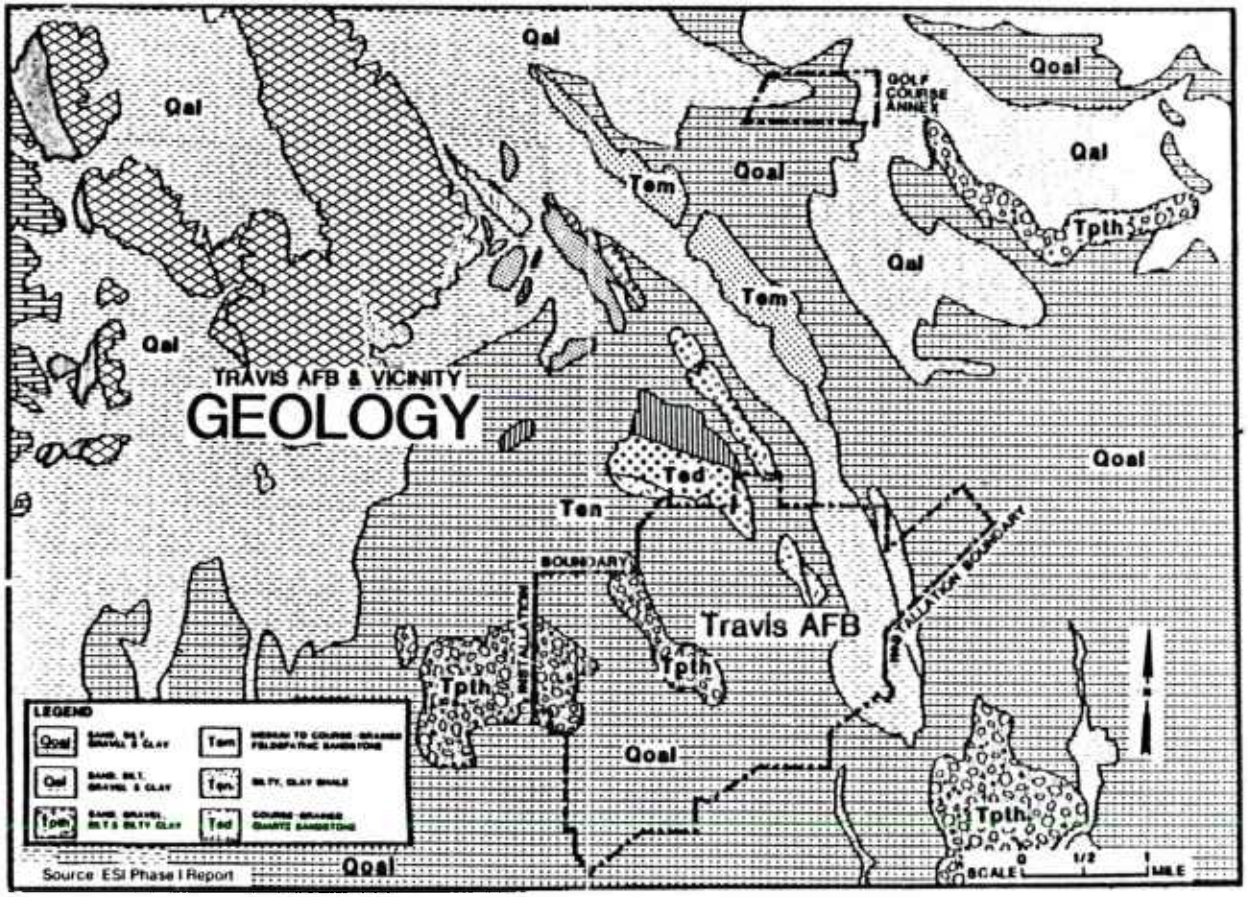

FIGURE 2-3 GEOLOGY OF TRAVIS AFB AND VICINITY

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The majority of the Base is underlain by alluvium of Pleistocene age (Qoal). This alluvium also consists of interfingering lenses of gravels, sands, silts, and clays. These deposits are up to 200 feet thick in areas southwest of Fairfield. However, at Travis AFB, these deposits are much thinner, overlying the basement rocks that are part of the outcropping of the Potrero Hills to the south.

Underlying the alluvium, and in some places outcropping at the surface, are the Tertiary age consolidated sediments interbedded with some volcanics. These Tertiary sediments are comprised of the Tehama Formation, which are nonmarine sediments of Plio-Pleistocene age, and the Markley Formation, Eocene age marine sediments. These deposits are as much as 7,500 feet thick in the Suisun-Fairfield Basin.

2.3 HYDROGEOLOGY

2.3.1 Regional Hydrogeology

Groundwater in the Suisun-Fairfield basin occurs in the alluvium and the Sonoma volcanics. The areas to the north and east of the Town of Fairfield are essentially barren of groundwater for uses greater than domestic or stock use. These areas are underlain by alluvium, however, the consolidated Cretaceous and Eocene rocks occur beneath the alluvium at very shallow depths.

West of Fairfield the alluvium attains a sufficient thickness to provide large quantities of water. Also, the pumiceous tuffs, tuff breccias, and flow rocks of the Sonoma volcanics are present to the west. The porous tuffs and fractured flow rocks provide good quality water to wells.

The general direction of groundwater flow is to the south towards the Suisun Marsh and Bay. Extensive development of the groundwater resources has only occurred west of Fairfield. This development has caused localized depressions within the aquifers and altered the natural pattern of groundwater movement to the south.

2.3.2 Site Hydrogeology

Travis AFB is not underlain by extensive water-bearing materials. Groundwater occurs within the lenses of coarser material in the alluvium, and only small quantities of water are available for domestic or stock purposes. Recharge to the groundwater occurs through direct precipitation and in-channel infiltration from Union and Denverton Creeks. Groundwater flows toward the Suisun Marsh and Bay to the south, generally following the surface topography.

2.3.3 Base Supply and Other Area Wells

2.3.3.1 Base Supply Wells

Groundwater resources at the Base and in its immediate surroundings are very limited, as discussed in Subsection 2.3. Due to these limitations, the water supply for Travis AFB is composed of purchased water from the City of Vallejo Water Department and water from off-site production wells, owned and operated by Travis AFB. These wells are located at the golf course annex, approximately 4 miles north of the Base. A maximum of 750 million gallons of water/year is purchased from the City of Vallejo; the source is surface water diverted from the Delta via the Cache Slough. The water is treated at a Vallejo treatment plant north of the Base.

The Base supply wells provide between 400 and 500 million gallons/year of potable water to the Base. Of the 10 wells at the golf course, 5 wells provide the water utilized. The other 5 wells were taken out of service in 1957 or 1958 (ESI, 1983). The well water is pumped to Reservoir No. 3 located on the Base where it is chlorinated and mixed with the purchased water from Vallejo.

2.3.3.2 Off-Base Wells

The off-Base, private wells near Travis AFB are shown in Figure 2-4. These wells range in depth from 21.7 feet to 90 feet, and are used for stock ponds and domestic supply. Selected wells are regularly sampled by the Department of Water Resources and the samples are analyzed for pH, cadmium, magnesium, sodium, calcium carbonate, sulfate, nitrate and chloride (Engineering-Science, 1983). In 1984, the California Department of Health sampled these wells and analyzed the samples for volatile organic compounds. No volatile organics were detected in any of the off-Base wells tested. These results are presented in Appendix D.

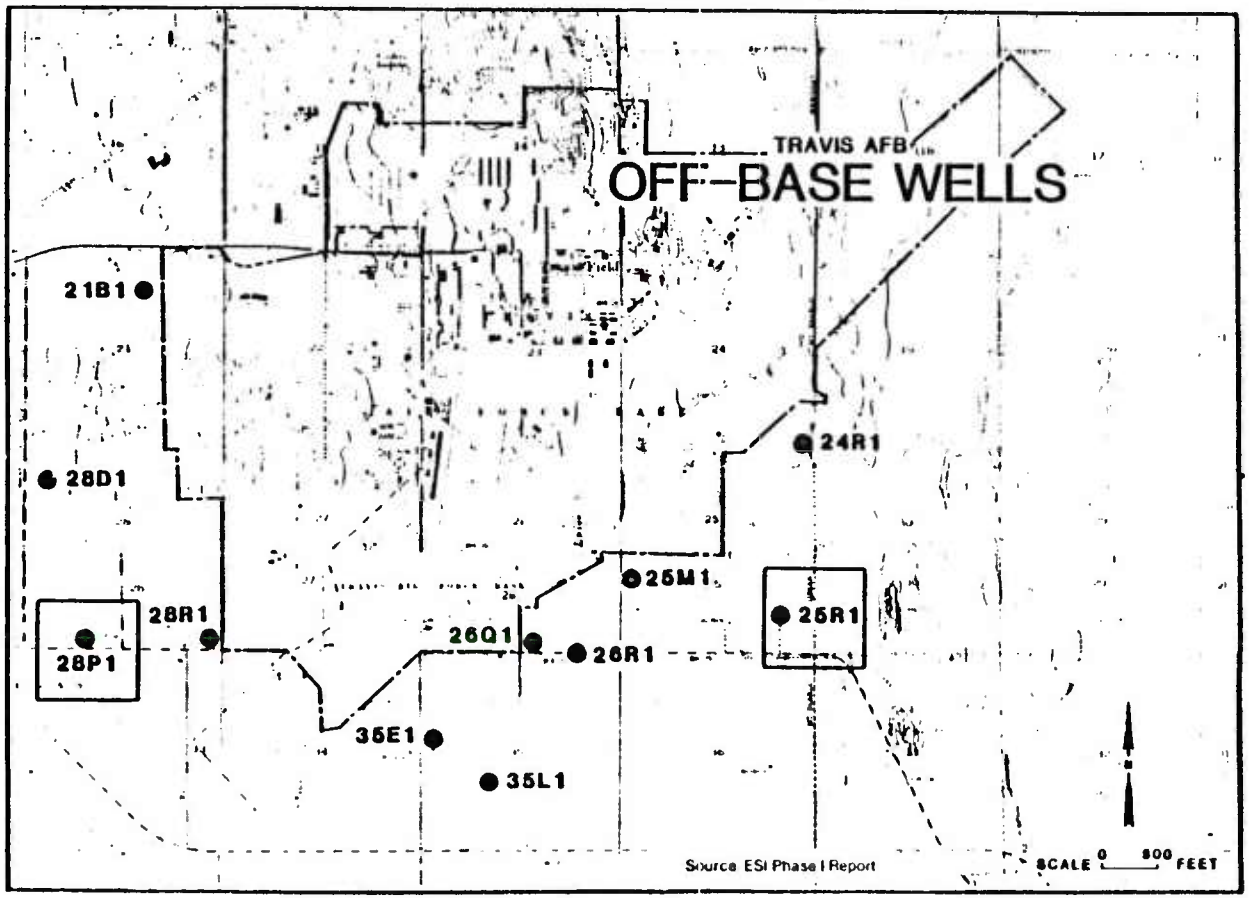

FIGURE 2-4 LOCATION OF OFF-BASE WATER SUPPLY WELLS

2.3.4 Groundwater Quality

Extensive studies of the groundwater quality in the immediate vicinity of the Base have not been undertaken; however, a 1985 publication by the U.S. Geological Survey has evaluated the chemical quality of groundwater in Solano County. The USGS study area does not include Travis AFB, however, the boundary is approximately 4 miles east of Travis AFB. The groundwater in the area nearest the Base has been characterized as sodium-bicarbonate or sodium-calcium-bicarbonate water (i.e., water in which bicarbonate amounts to 50 percent or more of anions in milliequivalents/liter (meq/L), and sodium and/or calcium are first or second in order of abundance of cations).

Hardness in the groundwater is generally less than 180 mg/L (as $CaCO_3$). Due to the depositional environment (lagoonal) of the sediments, the natural water quality contains elevated concentrations of chlorides and total dissolved solids. Total dissolved solids are generally greater than 500 mg/L, and chlorides are greater than 100 mg/L. Boron values range from 1 to 2 mg/L. The groundwater quality has been characterized as being of marginal chemical quality due to the concentrations of chlorides, boron, and total dissolved solids (Evenson, 1985).

Groundwater in the immediate vicinity of the Base has been sampled from two domestic wells for a number of years. These wells are designated 5N1W/25R1 and 5N1W/28P1, and are shown in Figure 2-4. The results of the chemical analyses are included in Appendix D. In general, well 5N1W/25R1 shows a more degraded water quality than well 5N1W/28P1. Chlorides in both wells are, for the most part, greater than 100 mg/L. Total dissolved solids occasionally are greater than 500 mg/L. The nitrates in well 5N1W/25R1 exceed 10 mg/L on all sampling dates; nitrates in well 5N1W/28P1 are less than 10 mg/L.

SECTION 3

FIELD PROGRAM

3.1 PROGRAM DEVELOPMENT

Task Order 0004 (Appendix B) was issued on the basis of the Phase II presurvey report. Sites recommended for confirmation stage work in the Phase I report (ESI) were addressed in the Phase II program with modifications incorporated from the Phase II presurvey report. Due to a delay in obtaining access to privately-owned land near the Point Arena Air Force Station and a subsequent modified Task Order (Appendix C), a separate self-standing report will be prepared for the Point Arena AFS Zone.

The subsections that follow discuss the approved field investigation for the six zones/areas considered in this Phase II Problem Confirmation Stage 1 study report.

3.1.1 Storm Sewer Zone

The approved scope of work developed from the recommendations in WESTON's presurvey report included the following individual sites in the Storm Sewer Zone (SSZ):

- Fire Training Area No. 1.
- Oil Spillage Area.
- Solvent Spillage Area.
- Contaminated Sewer Right-of-Way.

The tasks included in the scope of work were as follows:

1. Drill and install 12 monitoring wells within the zone distributed among the individual sites as specified:
   - One well downgradient of Fire Training Area No. 1.
   - Two wells downgradient of the Oil Spillage Area.
   - One well upgradient and two wells downgradient of the Solvent Spillage Area.
   - Six wells at sites of opportunity along the contaminated Sewer Right-of-Way.

2. Collect soil samples from the six well boreholes being located in the Fire Training Area No. 1, the Oil Spillage Area, and the Solvent Spillage Area for the chemical analyses shown in Taole 1-5.

3. Establish 12 permanently marked and surveyed staff gauge stations along the contaminated Sewer Right-of-Way to a point near the storm sewer outfall along Union Creek.

4. Collect two rounds of water samples from all monitoring wells and staff gauge stations.

In addition, modification of the scope of work required the collection of stream sediment samples from five staff gauge stations along Union Creek. The sediments were analyzed for the parameters shown in Table 1-5.

The monitoring wells were installed and screened in the upper portion of the shallow unconfined water table aquifer to intercept any contaminants migrating toward the storm sewers. Groundwater and surface-water elevation surveys were completed during wet and dry seasonal conditions to define groundwater and surface-water flow directions and gradients, and the relationship between ground and surface waters. Two rounds of groundwater and surface-water samples were taken during the study period from the monitoring wells and staff gauge stations for analysis of the parameters shown in Table 1-5.

3.1.2 Fire Training Area No. 4

The approved scope of work developed from the recommendations in WESTON's presurvey report included the following tasks:

1. Drill and install four monitoring wells around the site. The locations will include one well upgradient and three wells downgradient of Fire Training Area No. 4.

2. Collect soil samples from the four well boreholes for chemical analyses of the parameters shown in Table 1-5.

3. Establish three permanently marked and surveyed staff gauge stations along Union Creek near the site.

4. Collect two rounds of water samples from all monitoring wells and staff gauge stations.

In addition, a modification of the scope of work required the collection of stream sediment samples from the three staff gauge stations. The sediments were analyzed for the parameters shown in Table 1-5.

The monitoring wells were installed and screened in the upper portion of the water table aquifer to intercept any contaminants emanating from the site. Groundwater and surface-water elevation surveys were completed during wet and dry seasonal conditions. Two rounds of groundwater and surface-water samples were taken for analysis for the parameters shown in Table 1-5.

3.1.3 North Landfill Zone

The approved scope of work developed from the recommendations in WESTON's presurvey report included the following individual sites within the North Landfill Zone (NLFZ):

- Landfill No. 1.
- Landfill No. 2.
- Fire Training Area No. 2.
- Fire Training Area No. 3.

The tasks included in the scope of work were as follows:

1. Drill and install 10 monitoring wells within the zone distributed among the individual sites as follows:
   - One well downgradient of Landfill No. 1.
   - Two wells upgradient and three wells downgradient of Landfill No. 2.
   - Two wells downgradient of Fire Training Area No. 2.
   - Two wells downgradient of Fire Training Area No. 3.
2. Collect soil samples from four well boreholes being located in Fire Training Areas No. 2 and No. 3 for the chemical analyses shown in Table 1-5.
3. Collect two rounds of water samples from all monitoring wells.

The wells were installed and screened in the upper portion of the water table aquifer to intercept any contaminants migrating from the sites. Groundwater elevation surveys were completed during wet and dry seasonal conditions. Two rounds of groundwater samples were taken from the wells for analysis of the parameters shown in Table 1-5.

3.1.4 Landfill No. 3

The approved scope of work developed from the recommendations in WESTON's presurvey report included the following tasks:

1. Drill and install three monitoring wells around the site. The locations will include one well upgradient and two wells downgradient of Landfill No. 3.

2. Collect two rounds of water samples from all monitoring wells.

The wells were installed and screened in the upper portion of the water table aquifer. Groundwater elevation surveys were completed during wet and dry seasonal conditions and two rounds of groundwater samples were taken for analysis for the parameters shown in Table 1-5.

3.1.5 JP-4 Spill (1978)

The approved scope of work developed from the recommendations in WESTON's presurvey report included the following tasks:

1. Drill and install one monitoring well downgradient of the JP-4 Spill Area.

2. Collect two rounds of water samples from the monitoring well.

The well was installed and screened in the upper portion of the water table aquifer to intercept any contaminants migrating from the site. Groundwater elevation surveys were completed during wet and dry seasonal conditions and two rounds of groundwater samples were taken from the well for analysis of the parameters listed in Table 1-5.

3.1.6 Sewage Treatment Plant Zone

The approved scope of work developed from the recommendations in WESTON's presurvey report included the following tasks:

1. Drill and install four monitoring wells within the zone, generally located as follows:
   - One well upgradient of the inactive Sewage Treatment Plant.
   - One well between the inactive oxidation ponds and the inactive treatment plant.
   - Two wells downgradient of the inactive oxidation ponds (between the ponds and the south Base boundary).
2. Establish three permanently marked and surveyed staff gauge stations along Union Creek near the former Sewage Treatment Plant outfall.
3. Collect two rounds of water samples from all monitoring wells and staff gauge stations.

In addition, a modification of the scope of work required the collection of stream sediment samples from the three staff gauge stations along Union Creek. The sediments were analyzed for the parameters shown in Table 1-5.

The wells were installed and screened in the upper portion of the water table aquifer to intercept contaminants migrating from the site. Groundwater and surface-water elevation surveys were completed during wet and dry seasonal conditions, and two rounds of water samples were taken from the monitoring wells and staff gauge stations. The water samples were analyzed for the parameters listed in Table 1-5.

3.1.7 Analytical Protocol

The analytical protocol summarized in Table 1-5 was selected for the six zones/areas addressed in this Phase II study. The parameters chosen are specific and nonspecific indicators of contamination.

3.1.8 Formal Scope of Work

Task Order 0004 formalized the proposed work and is included in Appendix B of this report. The scope of work was subsequently modified in Task Order 000401 (Appendix C). The original Task Order and the modified Task Order provided the basis for the implementation of the field program described in the subsections that follow.

3.2 HYDROGEOLOGICAL INVESTIGATION

A field investigation has been conducted to define the hydrological and geological settings at Travis AFB, and to evaluate the possible presence of hazardous environmental contaminants that may have resulted from past waste disposal or product handling practices at the Base. Information regarding potential or actual impacts of the six zones/areas of study on area groundwater, surface water, and soils was obtained from 34 onsite monitoring wells and 19 staff gauge stations.

During the installation of the monitoring wells, split-spoon samples were taken at regular intervals to obtain samples of the unconsolidated sediments in the unsaturated and saturated zones for visual inspection. In addition, at certain zones/areas, split-spoon samples were collected for chemical analyses, as specified in the Task Order. The wells also provided measuring points for identifying groundwater flow directions and gradients in the shallow unconfined water table aquifer at the sites.

At the staff gauge stations located along Union Creek, a 1-foot bottom sediment core sample was taken for chemical analyses, as specified in the modified Task Order. The staff gauge stations also provided stream and storm drain elevations useful in identifying the interrelationship between groundwater and surface water. The field work is summarized on a site-by-site basis in Table 3-1.

3.2.1 Schedule of Activity

The field investigation at Travis AFB commenced on 15 October 1984 and was completed on 16 May 1985. Table 3-2 is a summary of WESTON's field activities schedule at Travis AFB.

WESTON

Table 3-1

Summary of Field Activity

Site	Activity
Storm Sewer Zone FTA-1, Oil Spill, Solvent Spill, contaminated Sewer Right-of-Way	Install 12 groundwater monitoring wells and sample twice (wet and dry seasons). Establish 12 staff gauge stations and sample twice (wet and dry seasons). Sample five staff gauge station sediments. Perform well, staff gauge, groundwater, and surface-water elevation surveys.
Fire Training Area No. 4	Install four groundwater monitoring wells and sample twice (wet and dry seasons). Establish three staff gauge stations and sample twice (wet and dry seasons). Sample staff gauge station sediments. Perform well, staff gauge, groundwater, and surface-water elevation surveys.
North Landfill Zone LF-1, LF-2, FTA-2, FTA-3	Install 10 groundwater monitoring wells and sample twice (wet and dry seasons). Perform well and groundwater elevation surveys.
Landfill No. 3	Install three groundwater monitoring wells and sample twice (wet and dry seasons). Perform well and groundwater elevation surveys.
JP-4 Spill (1978)	Install one groundwater monitoring well and sample twice (wet and dry seasons). Perform well and groundwater elevation surveys.
Sewage Treatment Plant Zone	Install four groundwater monitoring wells and sample twice (wet and dry seasons). Establish three staff gauge stations and sample twice (wet and dry seasons). Sample staff gauge sediments. Perform well, staff gauge, groundwater, and surface-water elevation surveys.

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Table 3-2

Schedule of Field Investigation Accomplishments,
Travis AFB

Date	Activity
15 October 1984	Preconstruction visit to locate well and staff gauge sites, and meet with Base officials.
5-20 December 1984	Drilling, construction, and development of groundwater monitoring wells.
7-31 January 1985	Drilling, construction, and development of groundwater monitoring wells. Installation of staff gauges.
8-18 February 1985	Surveying of elevations of groundwater monitoring wells and staff gauges. Ground- and surface-water elevation surveys.
8-28 March 1985	First round of ground- and surface-water sampling. Ground- and surface-water elevation surveys. Sediment sampling.
16 and 26 April 1985	Ground- and surface-water elevation surveys.
3-16 May 1985	Second round of ground- and surface-water elevation surveys.

3.2.2 Drilling Program

The field program at Travis AFB included the installation of 34 groundwater monitoring wells with some soil samples taken for chemical analysis. The work was completed by drilling crews from Datum Exploration, Inc., subcontracted to Stang Hydronics, Inc. of Rancho Cordova, California. Two hollow-stem auger drilling rigs (Model CME 55) mounted on truck beds were utilized. A flex-track Model CME 75 rig was used to gain access for installation of one well behind Landfill No. 2, where the ground was very soft, and the wells in Fire Training Area No. 3. Augers and rigs were cleaned between drilling each monitoring well by washing with a high-pressure potable water source on the Base.

Representative soil samples from each sampling interval were taken with split-spoon samplers and standard penetration test (SPT) procedures in accordance with ASTM Test D-1586. During drilling and sampling, boring logs of the results were prepared; these logs are presented in Appendix E.

A HNu organic vapor detector with an 11.7-eV bulb was utilized to monitor air quality at the borings and in the split-spoon sampler during drilling. The readings are included on the boring logs contained in Appendix E. Samples taken during drilling were preserved in glass jars and are maintained at the Base Bioenvironmental Engineer's office. Where soil samples were taken for chemical analyses, specific procedures were followed to ensure sample integrity. These procedures are summarized in Aopendix H. At locations where chemical analyses of soils were required, three samples from specific depth intervals were chosen for analysis. The remaining samples are stored at WESTON's Stockton, California laboratory.

3.2.2.1 Monitor Well Construction

The 34 groundwater monitoring wells were installed at optimal locations in the following manner. The hollow-stem auger was advanced to 20 feet below the first water encountered. Then 20 feet of 2-inch diameter stainless steel, wire-wound screen (0.020-inch slot) was connected to an appropriate length of 2-inch diameter flush-joint, threaded Schedule 40 PVC riser pipe. No solvents or glues were used at any casing joints. The assembled well was inserted through the hollow-stem augers with the top of the screen approximately 3 feet above the depth where first water was encountered. This was done to intercept any floating hydrocarbons that might be present on the water

table. However, due to perched and semi-confined groundwater conditions, the water levels rose above the top of the screens. The augers were withdrawn several feet as a sand pack (#2-/16) was poured into the annular space around the well screen to 5 feet above the top of the screen. Next, a 2-foot layer of bentonite pellets was placed on top of the sand pack to seal the screened interval from vertical infiltration through the annular space. The seal was completed by pouring a bentonite-cement grout into the annular space to the ground surface. Care was taken to prevent the annular space from collapsing and to produce a continuous grout seal above the sand pack.

Each well was completed with the installation of a 4-inch diameter steel protective casing with locking cap. At certain locations, several wells were completed flush with the ground surface in a cast cement vault with a cement cover. A typical well construction diagram for both types of installation is shown in Figures 3-1 and 3-2. Well construction summaries are included in Appendix E.

Each well was developed by pumping a minimum of five times the volume of standing water in the well and until the groundwater was clear of suspended solids.

3.2.2.2 Storm Sewer Zone

A total of 12 groundwater monitoring wells, screened in the upper section of the water table, were installed in the Storm Sewer Zone. The wells, numbered MW-101 through MW-112, were located at sites estimated in the field to correspond with the Task Order requirements. The locations are depicted in Figure 3-3. MW-101 is located downgradient of Fire Training Area No. 1. MW-102 and -103 are located downgradient of the Oil Spillage Area. MW-104 is located upgradient of the Solvent Spillage Area, with MW-105 and -106 downgradient. MW-107 through MW-112 are located at sites of opportunity along the contaminated sewer right-of-way.

The monitoring wells ranged in depth from 28 to 52 feet below ground surface, and groundwater was encountered from 7 to 11 feet below ground surface. The wells were screened in fine to medium sands and silts to approximately 3 feet above first encountered groundwater. Each well boring, except MW-109, encountered a stiff, dry to moist clay at the bottom. The well construction summaries are depicted in Figure 3-4. Subsurface conditions are discussed in detail in Section 4.

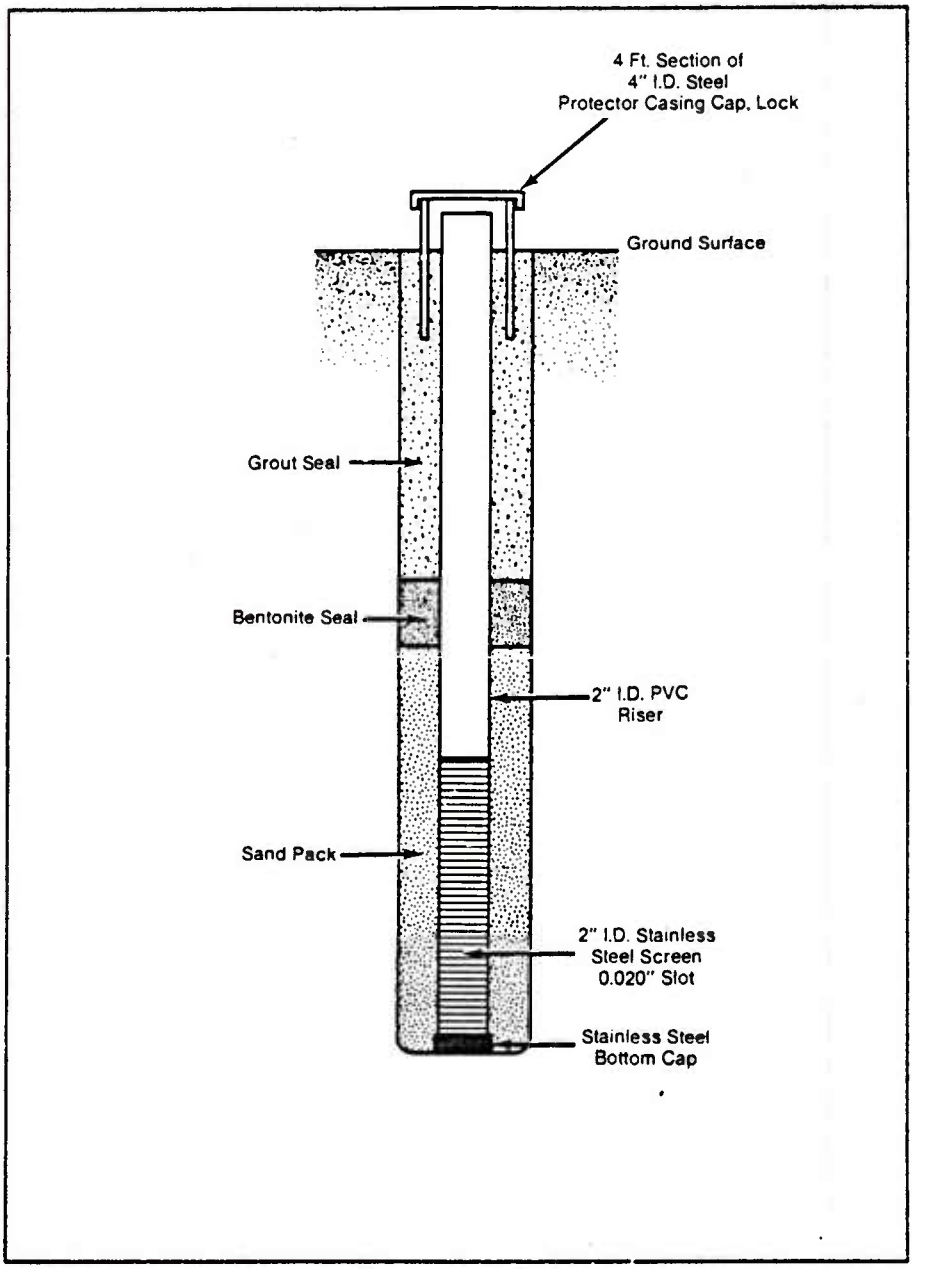


FIGURE 3-1 TYPICAL MONITOR WELL CONSTRUCTION

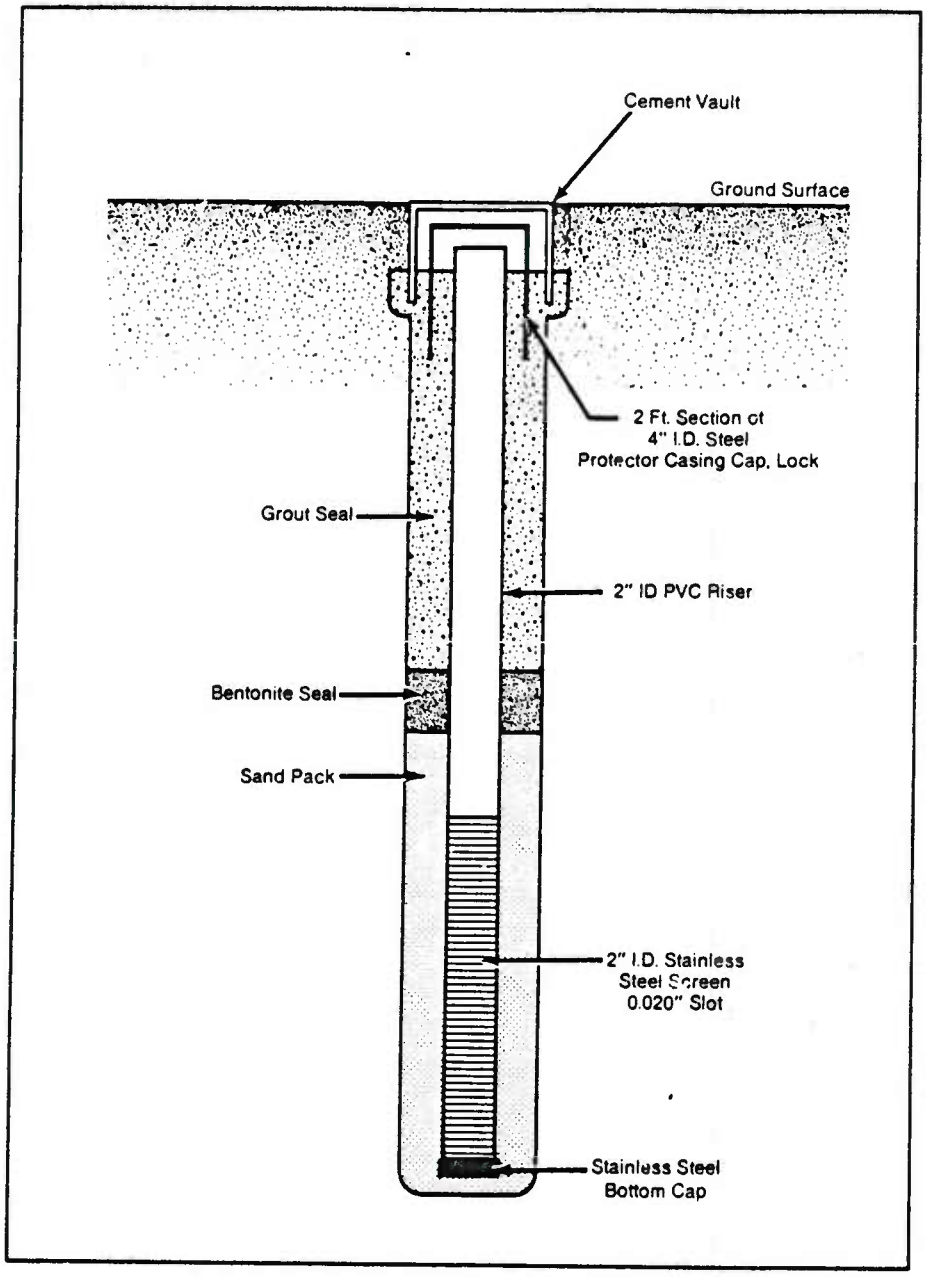
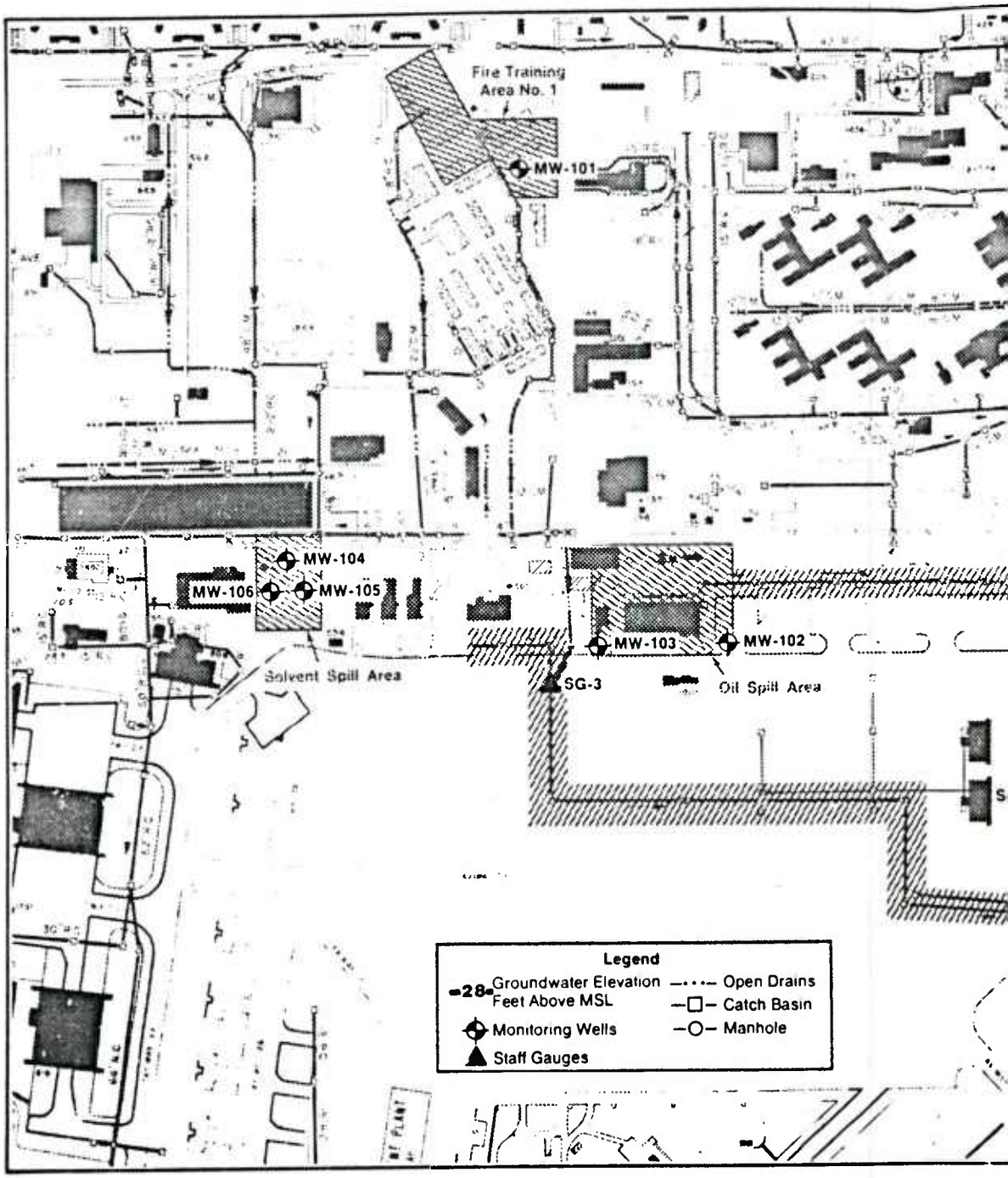


FIGURE 3-2 TYPICAL MONITOR WELL CONSTRUCTION FOR FLUSH MOUNTED WELLS


Fire Training
Area No. 1
MW-101
MW-104
MW-106
MW-105
MW-103
MW-102
Solvent Spill Area
SG-3
Oil Spill Area
Legend
-28- Groundwater Elevation
Feet Above MSL
Monitoring Wells
Staff Gauges
Open Drains
Catch Basin
Manhole

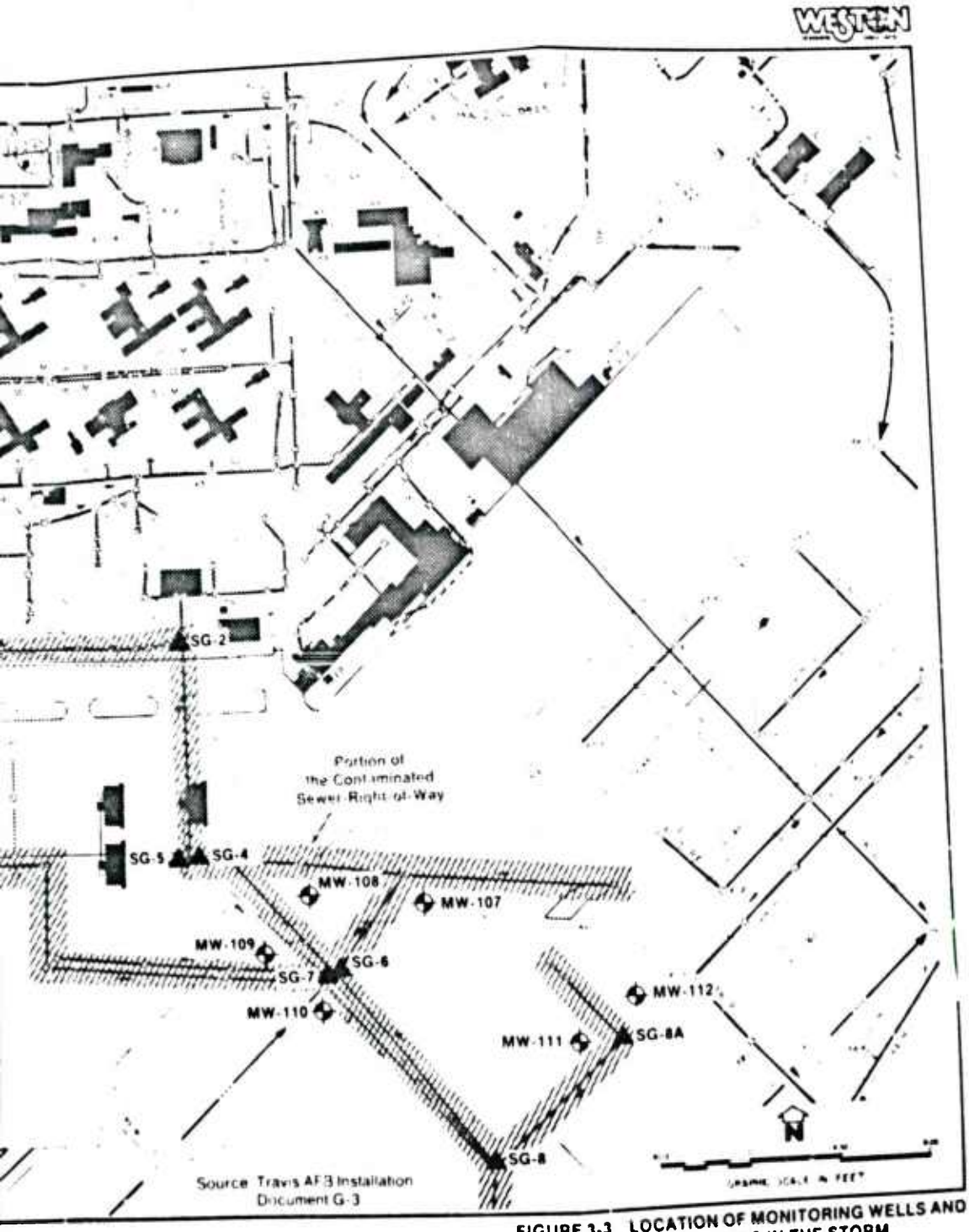
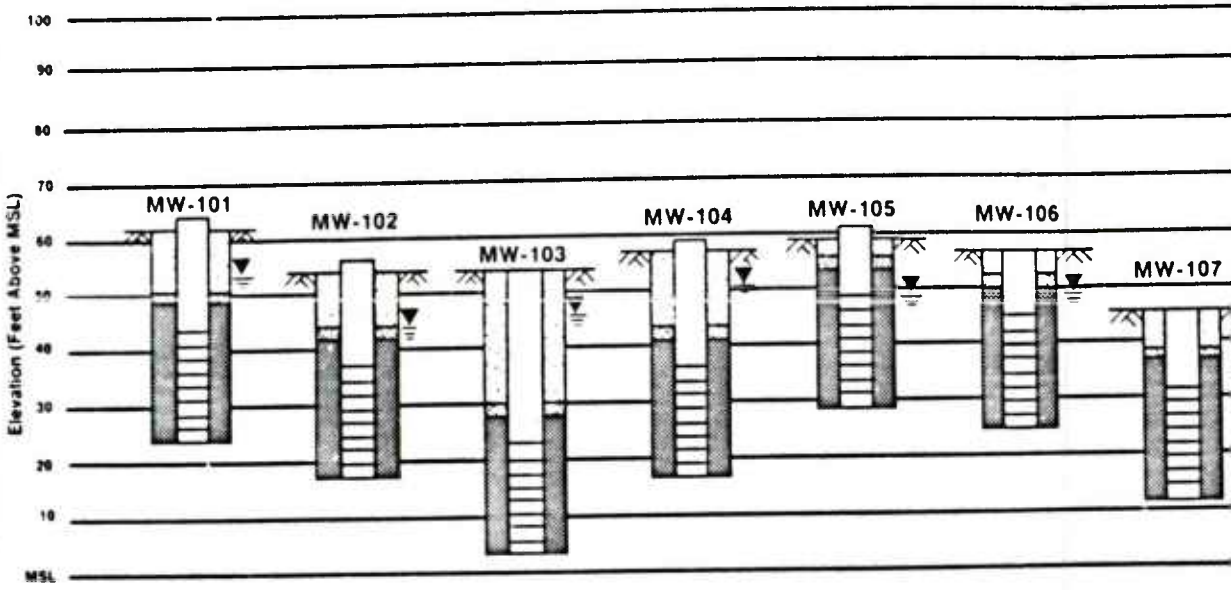


FIGURE 3-3 LOCATION OF MONITORING WELLS AND STAFF GAUGES IN THE STORM SEWER ZONE


100
90
80
70
60
50
40
30
20
10
MSL
Elevation (Feet Above MSL)
MW-101
MW-102
MW-103
MW-104
MW-105
MW-106
MW-107

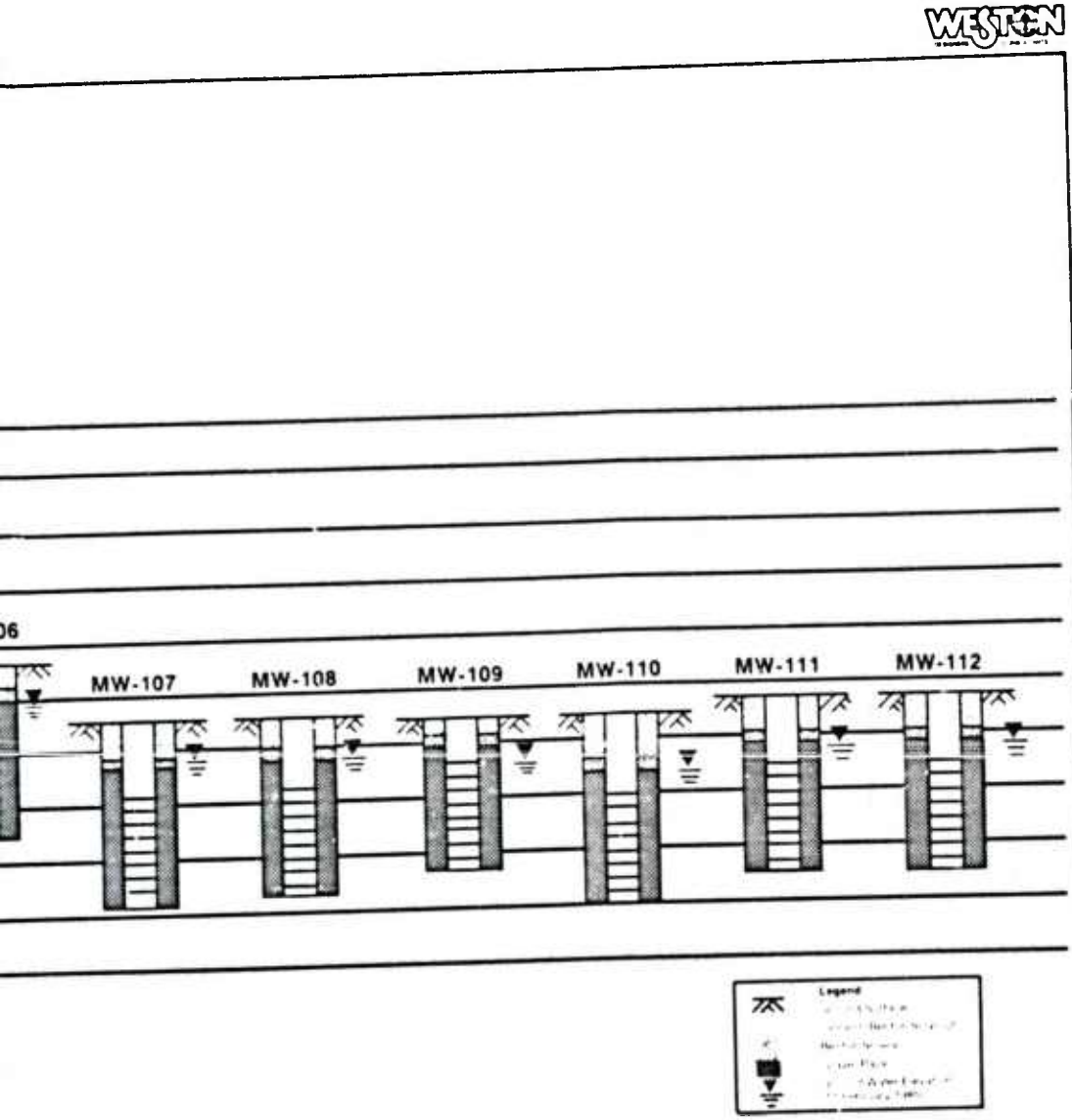


FIGURE 3-4 WELL CONSTRUCTION SUMMARY, STORM SEWER ZONE

3.2.2.3 Fire Training Area No. 4

Four groundwater monitoring wells (MW-117 through MW-120) were installed around Fire Training Area No. 4 (FTA-4). The wells are screened in the upper portion of the water table aquifer. The well locations are depicted in Figure 3-5. MW-118 is located upgradient of FTA-4 and MW-117, MW-119, and MW-120 are located downgradient. The monitoring wells range in total depth from 27 to 37 feet below the ground surface. Groundwater was encountered at depths ranging from 13 to 15 feet below ground surface. Sediments encountered included silty clays and silty sands. Well construction summaries are presented in Figure 3-6.

3.2.2.4 North Landfill Zone

A total of 10 groundwater monitoring wells were installed around various sites in the North Landfill Zone (NLFZ). The well locations are depicted in Figure 3-7. Two monitoring wells, MW-125 and MW-126, are upgradient of Landfill No. 2 and three monitoring wells, MW-127 through MW-129, are located downgradient of Landfill No. 2. MW-130 is located downgradient of Landfill No. 1, MW-131 and MW-132 are located downgradient of Fire Training Area No. 3, and MW-133 and MW-134 are located downgradient of Fire Training Area No. 2. The wells range in depth from 26 feet to 40 feet below ground surface, with groundwater encountered at 2 to 8 feet below ground surface. A dry hardpan clay was encountered at depths ranging from 15 to 31 feet below ground surface in wells MW-125, MW-126, MW-127, and MW-130. The wells were screened in interbedded silty sands and clays. Well construction summaries are presented in Figure 3-8.

3.2.2.5 Landfill No. 3

Three groundwater monitoring wells were installed around Landfill No. 3 (LF-3). MW-113 is located upgradient of the landfill, with MW-114 and MW-115 located downgradient. The monitoring wells range in depth from 45 to 50 feet below ground surface. Groundwater was encountered during the drilling at depths ranging from 28 to 38 feet below ground surface. Sediments encountered were generally fine-grained, interbedded silty sands and clays. The well locations are depicted in Figure 3-9, and construction summaries are depicted in Figure 3-10.

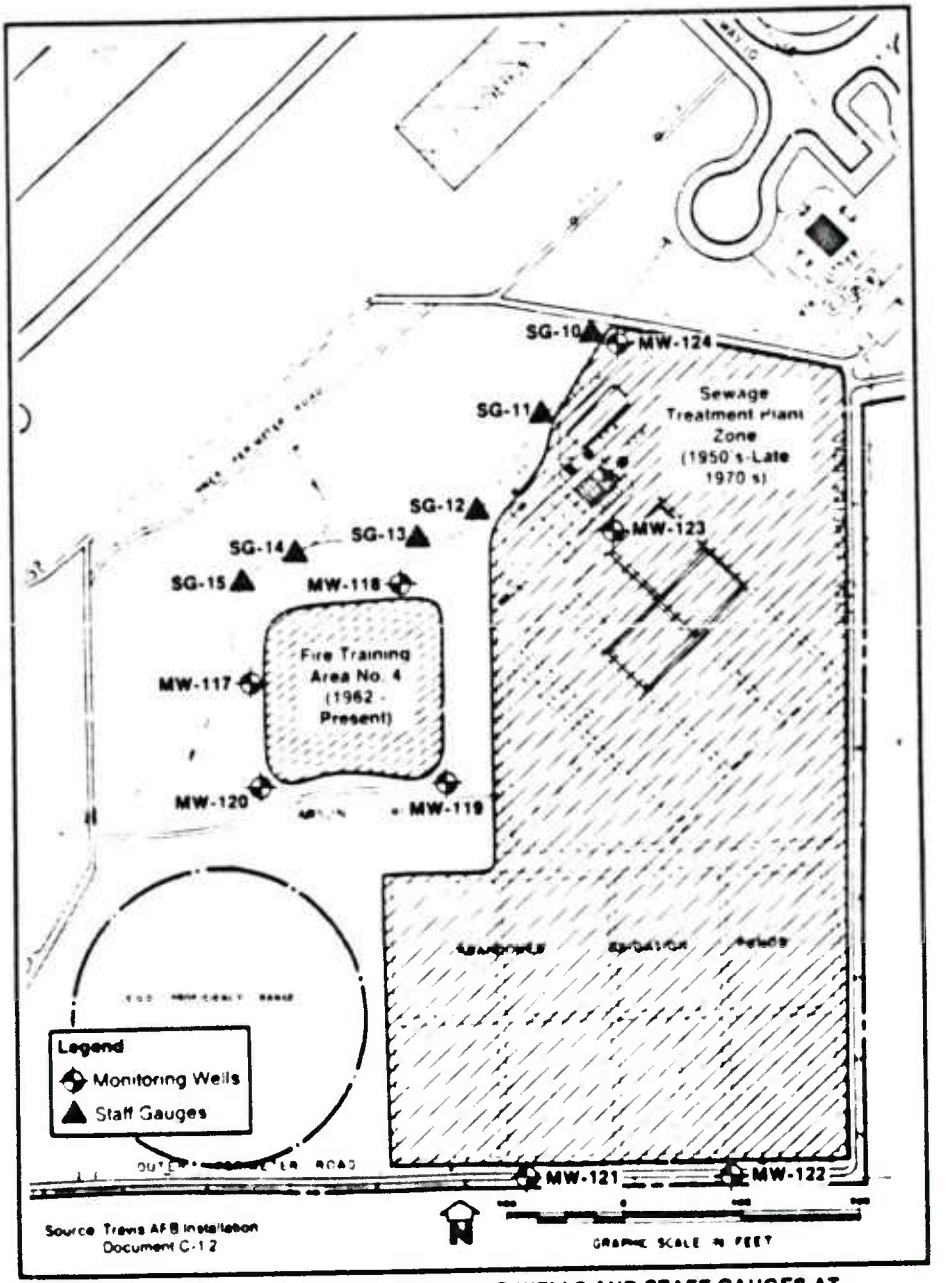
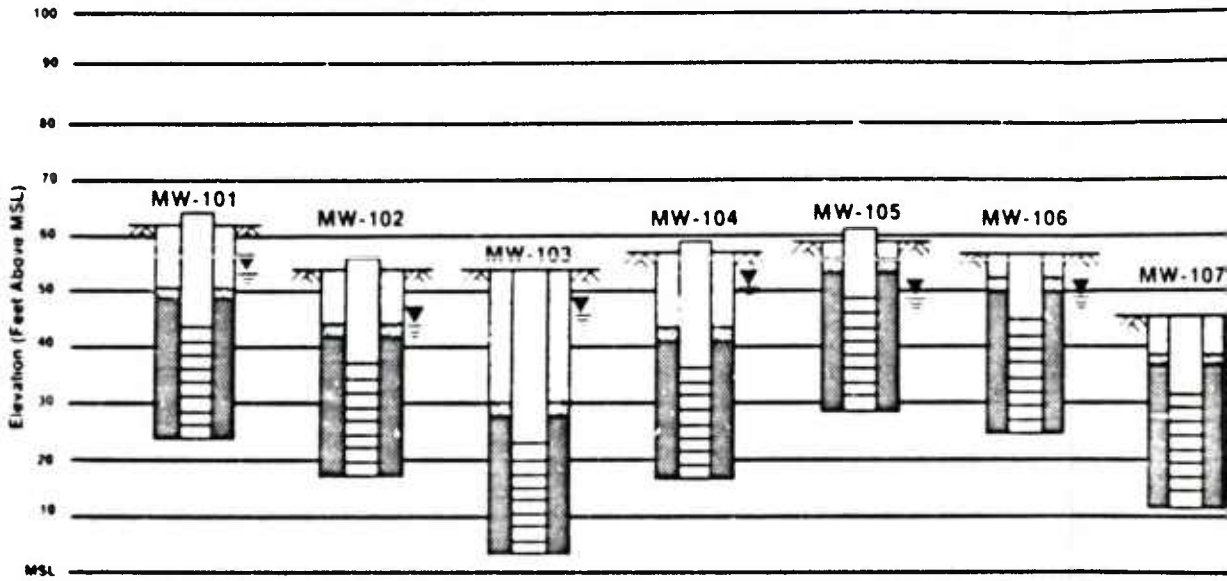


FIGURE 3-5 LOCATION OF MONITORING WELLS AND STAFF GAUGES AT THE SEWAGE TREATMENT PLANT ZONE AND FIRE TRAINING AREA NO. 4


100
90
80
70
60
50
40
30
20
10
MSL
Elevation (Feet Above MSL)
MW-101
MW-102
MW-103
MW-104
MW-105
MW-106
MW-107

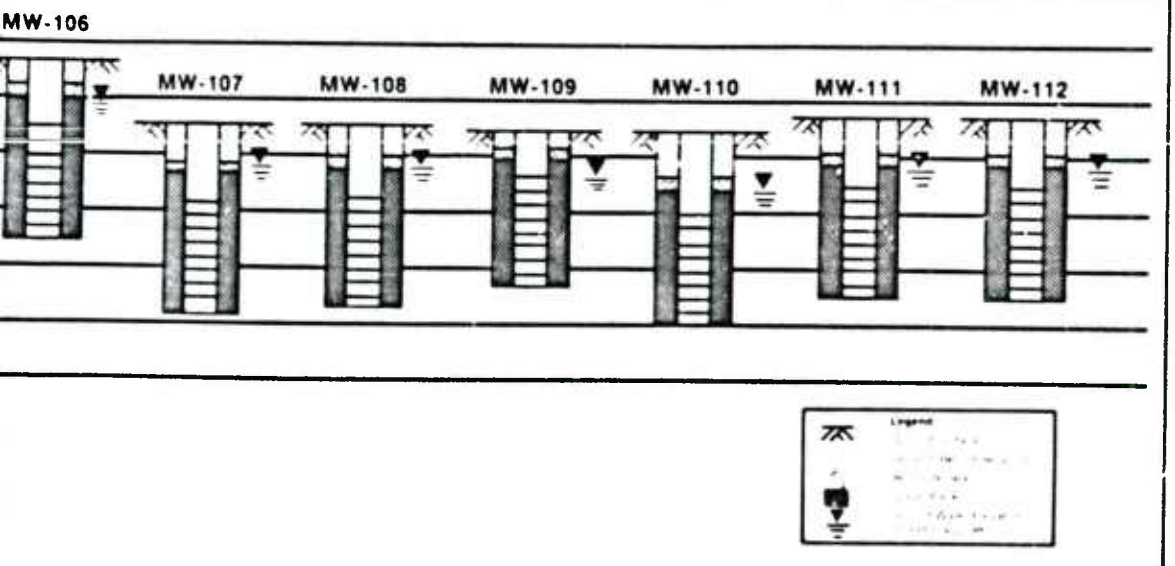


FIGURE 3-4 WELL CONSTRUCTION SUMMARY, STORM SEWER ZONE

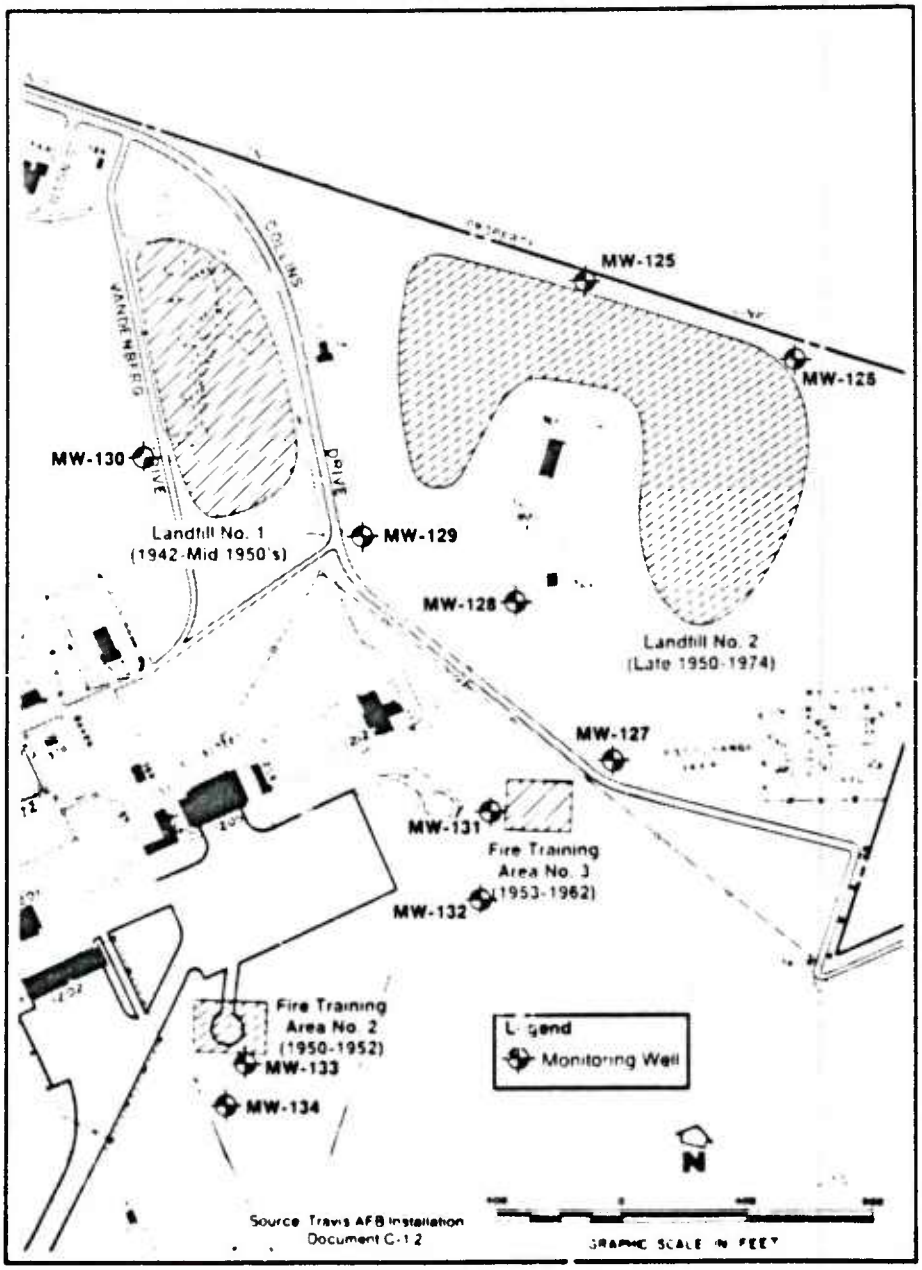
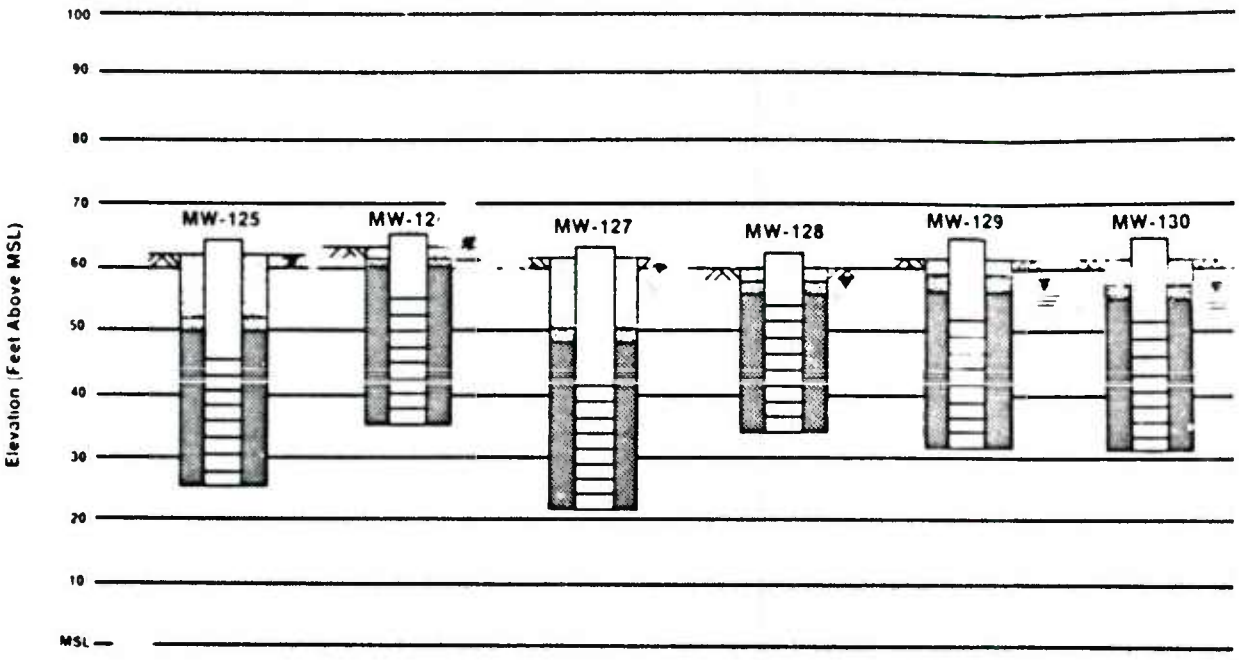


FIGURE 3-7 LOCATION OF MONITORING WELLS AT THE NORTH LANDFILL ZONE


Elevation (Feet Above MSL)
100
90
80
70
60
50
40
30
20
10
MSL
MW-125
MW-12
MW-127
MW-128
MW-129
MW-130

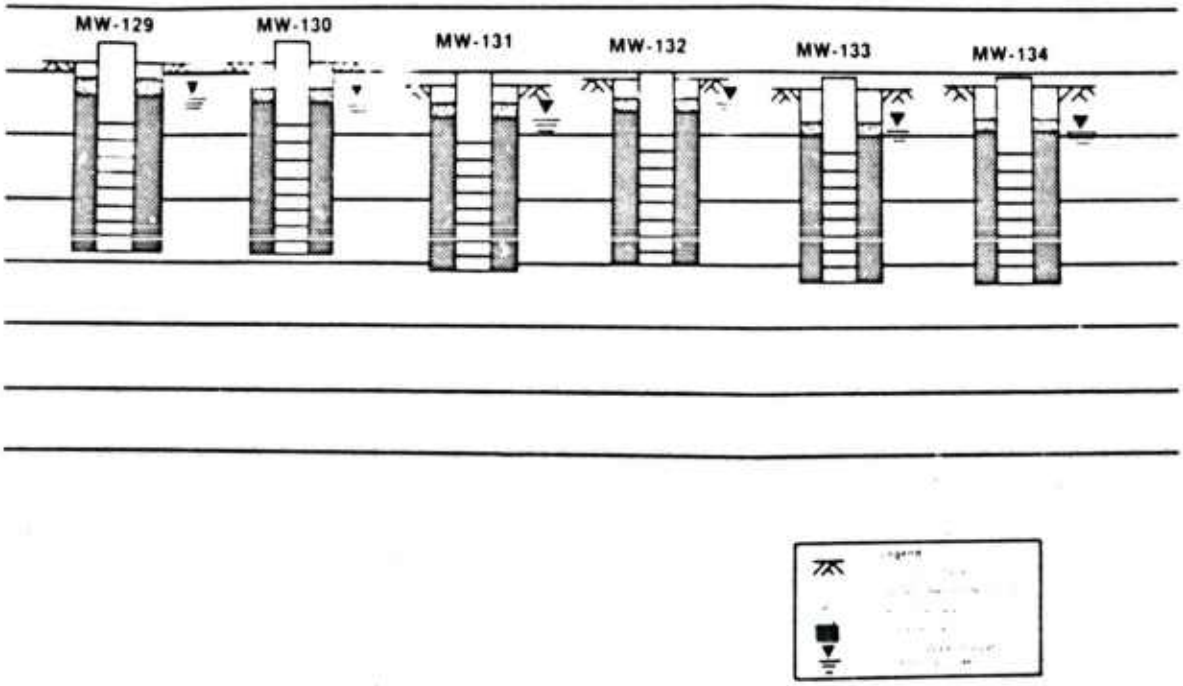


FIGURE 3-8 WELL CONSTRUCTION SUMMARY, NORTH LANDFILL ZONE

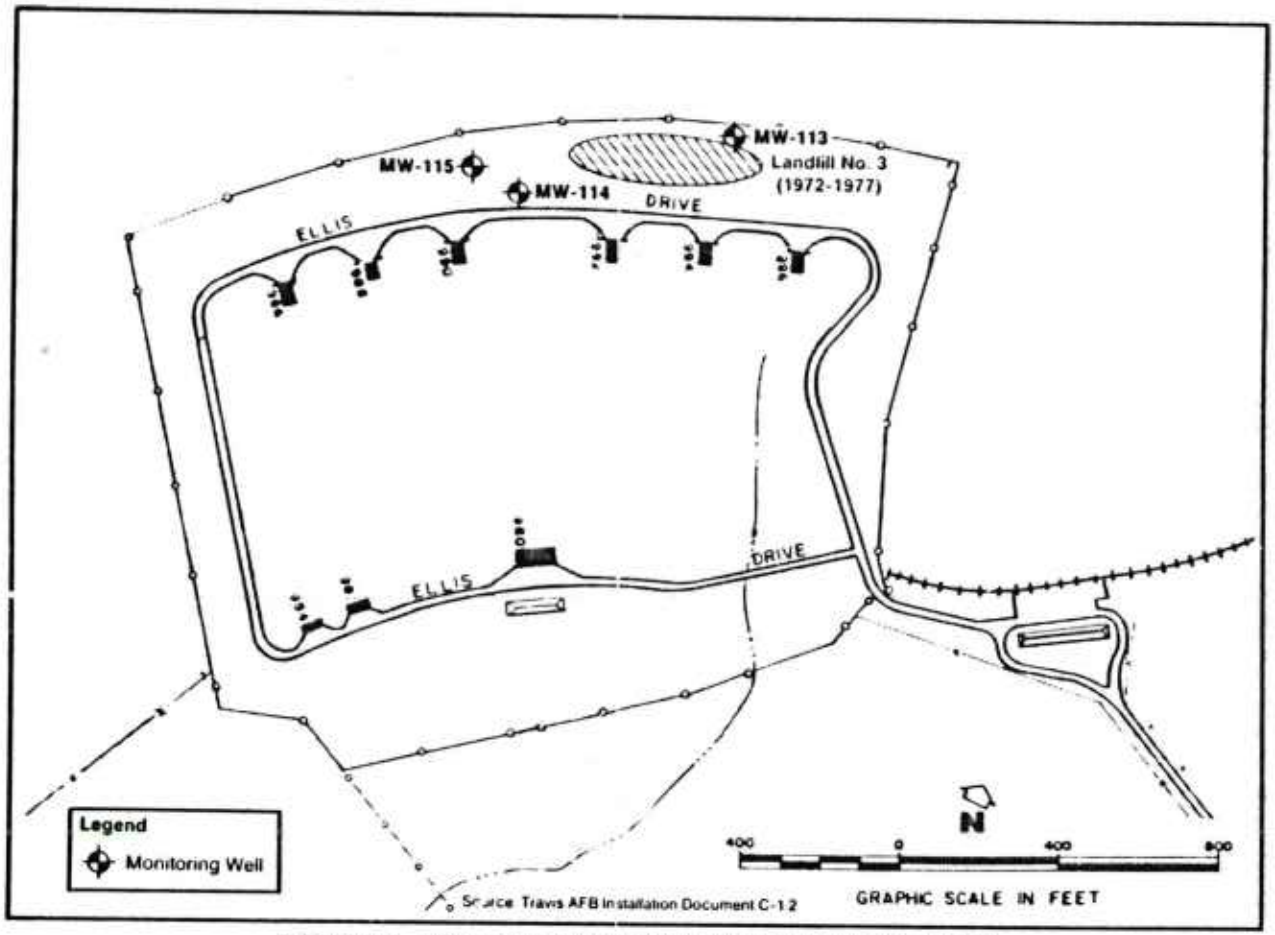


FIGURE 3-9 LOCATION OF MONITORING WELLS AT LANDFILL NO. 3

WESTON

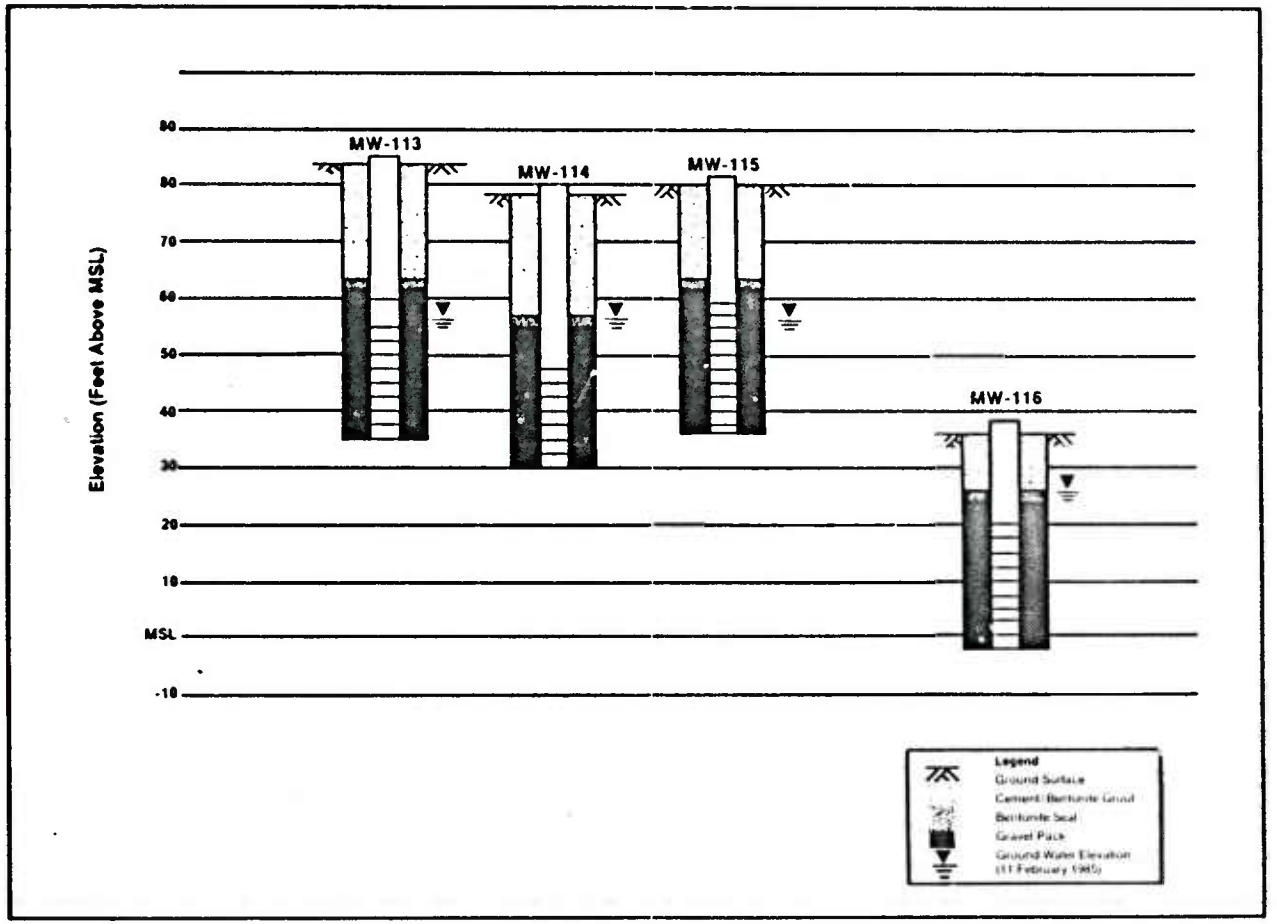


FIGURE 3-10 WELL CONSTRUCTION SUMMARY,
LANDFILL NO. 3 AND JP-4 SPILL SITE

3.2.2.6 JP-4 Spill

One groundwater monitoring well, MW-116, was installed downgradient of the 1978 JP-4 Spill Area. Its location is shown in Figure 3-11. The well is 38 feet in depth, and groundwater was encountered 23 feet below ground surface. The well is screened in sediments consisting of sandy clays and clays with water-bearing sand lenses. Well construction summaries are presented in Figure 3-10.

3.2.2.7 Sewage Treatment Plant Zone

A total of four groundwater monitoring wells have been installed throughout the Sewage Treatment Plant Zone (STPZ). MW-121 and MW-122 are located downgradient of the Sewage Treatment Plant, between the inactive oxidation ponds and the southern Base boundary. MW-123 is located between the inactive treatment plant and the inactive oxidation ponds. MW-124 is upgradient of the Sewage Treatment Plant at the intersection of Inner Perimeter Road and Vallejo Road. The monitoring well locations are depicted in Figure 3-5. The total depth of the wells range from 32 to 36 feet below ground surface. Groundwater was encountered from 12 to 15 feet below ground surface. Sediments encountered include fine sands, silts, and clays. Well construction summaries are depicted in Figure 3-6.

3.2.3 Field Testing

3.2.3.1 Groundwater Elevation Survey

A licensed California surveyor established the elevations of the staff gauges and the top of the PVC well casing at the monitoring wells. These measuring point elevations are used as reference points for determining the elevation of surface-water and groundwater at that location. The surface-water and groundwater elevations are used to refine flow directions and gradients, and to evaluate if the groundwater and surface-water regimes are connected in any way. All elevations are referenced to permanent benchmarks located on the Base property. Table 3-3 presents a list of the staff gauge and well elevations.

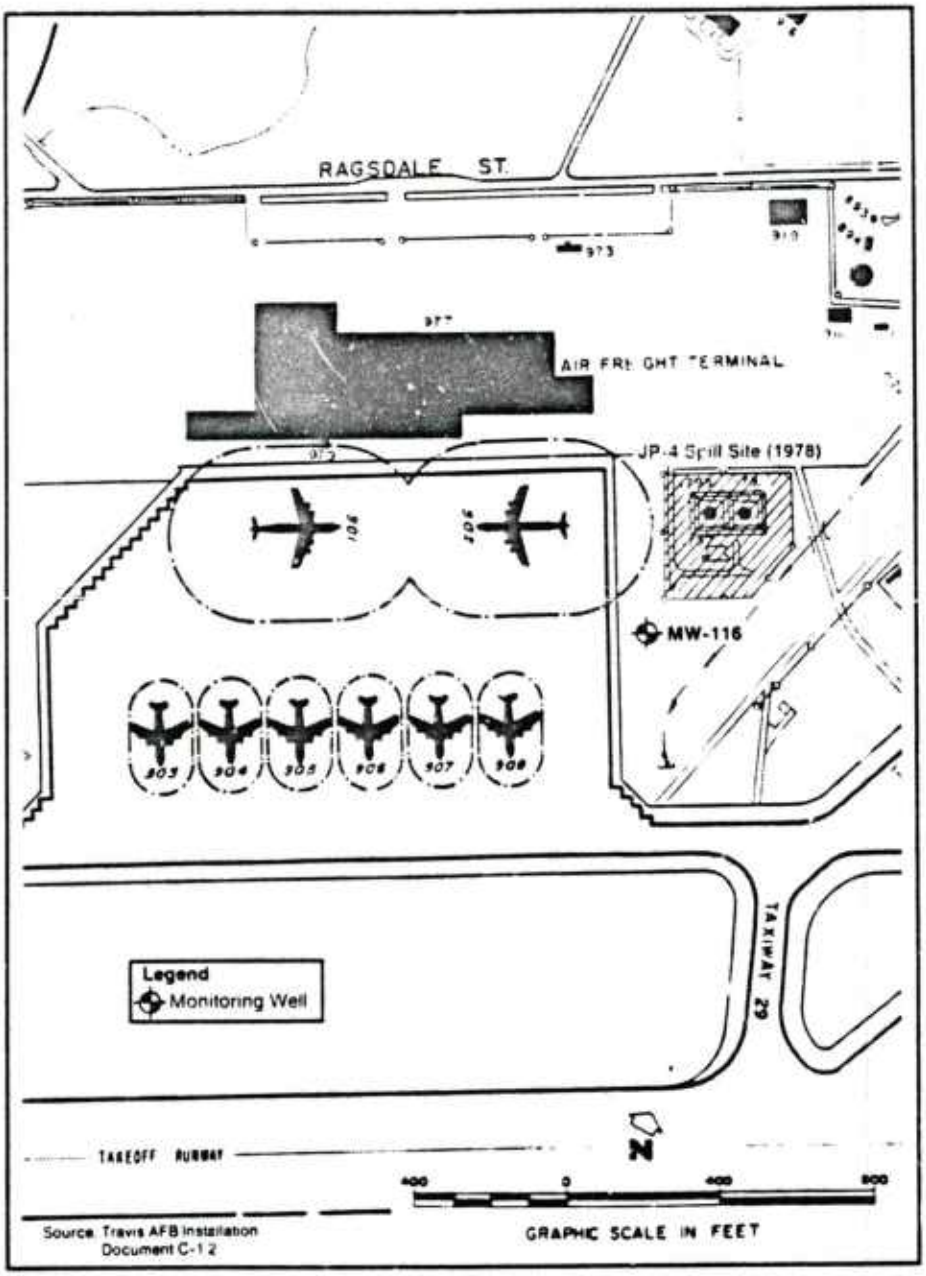


FIGURE 3-11 LOCATION OF THE MONITORING WELL AT THE JP-4 SPILL SITE

Table 3-3

Summary of Monitoring Well and Staff Gauge Elevation Survey

Monitoring Well or Staff Gauge	Elevation of PVC Well Casing or Top of Staff Gauge (ft above MSL)
MW-101	63.65
MW-102	55.66[a]
MW-103	53.89
MW-104	59.12
MW-105	61.06
MW-106	57.54
MW-107	45.93
MW-108	46.01
MW-109	45.05
MW-110	44.96
MW-111	46.83
MW-112	46.66
MW-113	85.26
MW-114	80.27
MW-115	81.30
MW-116	38.10
MW-117	45.75
MW-118	44.48
MW-119	41.56
MW-120	44.71
MW-121	37.81
MW-122	37.17
MW-123	43.57
MW-124	44.34
MW-125	64.47
MW-126	65.62
MW-127	63.28
MW-128	62.12
MW-129	63.98
MW-130	63.76
MW-131	60.11
MW-132	60.45
MW-133	59.02
MW-134	59.29

Table 3-3
(continued)

Monitoring Well or Staff Gauge	Elevation of PVC Well Casing or Top of Staff Gauge (ft above MSL)
SG-1	62.53[b]
SG-2	50.29
SG-3	53.67
SG-4	43.83
SG-5	43.91
SG-6	44.48
SG-7	44.49
SG-8	45.39
SG-8A	44.49
SG-9	34.34
SG-10	36.06
SG-11	34.75
SG-12	34.26
SG-13	34.10
SG-14	32.55
SG-15	33.31
SG-16	28.60
SG-17	24.32
SG-18	16.97

[a]Well casing damaged on approximately 8 May 1985 -- new elevation is 55.58.

[b]Staff gauge removed prior to survey. This elevation represents the top of a culvert entering the stream.

3.2.3.2 Water Level Measurements

A total of seven complete rounds of water levels were taken. Three rounds were taken during the wet season (11 February 1985, 11 March 1985, and 28 March 1985) and four rounds were taken in the dryer season (16 and 26 April 1985, 3 May 1985, and 16 May 1985). Water levels taken in March and May corresponded to periods of water sampling at the Base. All readings were referenced to the top of the PVC casing or staff gauge. Groundwater levels were measured using a Soiltest Model DR 706A water level probe or equivalent. The surface-water levels were read directly off the staff gauges. The measurements and calculated water elevations are presented in Appendix F.

3.2.3.3 Field Testing for Water Quality

While taking groundwater samples for laboratory analyses during the March and May 1985 sampling events, the WESTON field team also analyzed grab samples for temperature, specific conductivity, and pH. The results of these field tests are presented in Tables 3-4 through 3-7. Field sampling sheets are included in Appendix G.

3.2.3.4 Water Quality Sampling

The purpose of the water quality sampling program was to identify, insofar as possible at the level of a confirmation survey, the location, concentration, and areal extent of any contamination present in the hydrogeological environment. From this information and other data gathered it is possible to deduce the general direction in which these contaminants are migrating and their probable origin or source. To achieve these goals efficiently, specific field procedures were followed for purging the wells, collecting the samples, and ensuring field quality control. The sampling and quality assurance plans used to accomplish these goals are contained in Appendix H. These procedures were used to obtain two complete rounds of ground- and surface-water samples. These sampling events took place between 8 March and 22 March 1985, during wet seasonal conditions, and between 3 May and 16 May 1985, during dry seasonal conditions. The samples were collected and preserved as required for the chemical analyses to be performed as outlined in Table 1-5. Sample chain-of-custody documentation is included in Appendix I. Standard laboratory protocols used in the analysis of these samples are presented in Appendix J.

Table 3-4

Travis Air Force Base
Fairfield, California
Field Measurements -- March/May 1985

Area/Zone	Staff Gauge/ Monitor Well No.	pH (units)	Temperature (°C)	Specific Conductivity (umhos/cm)	Specific Conductivity Corrected to 25°C (umhos/cm)
Storm Sewer Zone					
FTA-1	MW-101	5.2/4.2	17.2/16.2	1,300/920	1,528/1,106
	MW-201[b]	5.2/4.1	17.2/17.0	1,300/930	1,528/1,098
Oil Spill Area	MW-102	6.4/6.2	21.0/20.8	2,100/1,750	2,274/1,903
	MW-103	7.1/7.2	20.0/20.5	2,000/2,070	2,211/2,265
Solvent Spill Area	MW-104	7.1/6.2	20.0/18.0	6,000/5,700	6,633/6,580
	MW-105	7.1/6.9	18.5/18.0	5,100/4,940	5,828/5,702
	MW-106	7.1/6.1	18.0/19.0	4,800/4,070	5,541/4,597
Sewer Right-of-Way	MW-107	7.4/7.2	19.0/20.0	1,500/1,363	1,694/1,507
	MW-108	7.5/7.5	21.0/21.0	2,000/973	2,165/1,053
	MW-109	7.7/7.3	19.0/22.0	1,900/1,216	2,146/1,290
	MW-110	7.8/7.6	18.0/19.1	1,100/1,108	1,270/1,249
	MW-111	7.1/7.1	19.0/19.4	3,700/2,690	4,179/3,012
	MW-112	7.1/6.9	18.0/21.4	3,300/3,240	3,809/3,479
	SG-1	7.9/8.4	15.0/23.0	1,685/643	2,083/699[c]
	SG-2	7.9/8.1	35.0/21.4	695/1,366	584/1,467
	SG-3	7.7/7.0	17.0/21.4	639/597	754/641
	SG-4	7.7/7.7	13.0/21.3	160/1,024	208/1,102
	SG-5	7.9/--[a]	17.0/--[a]	750/--[a]	885/--[a]
	SG-6	7.7/7.8	20.0/25.0	1,000/1,280	1,106/1,280
	SG-7	7.7/7.5	20.0/26.0	1,000/1,240	1,106/1,217
	SG-8	7.5/7.1	18.0/23.4	14,300/1,488	16,507/1,535[c]
	SG-8A	7.2/7.3	16.0/23.7	800/2,160	966/2,215
	SG-9	7.6/7.6	17.0/18.0	1,769/1,480	2,088/1,708
	SG-16	8.6/7.9	17.0/15.5	21,600/1,043	25,495/1,274[c]
	SG-17	8.6/7.8	15.0/17.0	27,300/1,007	33,745/1,189[c]
	SG-18	9.0/8.5	19.5/19.0	26,400/1,202	29,497/1,358[c]
	SG-318[b]	9.0/8.5	19.5/19.0	26,400/1,202	29,497/1,358[c]

[a]Dry -- not sampled.
[b]Duplicate sample.
[c]Gross differences in conductivity due to rainfall prior to sampling.

5915A

Table 3-5

Travis Air Force Base
Fairfield, California
Field Measurements -- March/May 1985

Area/Zone	Staff Gauge or Monitor Well No.	pH (units)	Temperature (°C)	Specific Conductivity (umhos/cm)	Specific Conductivity Corrected to 25°C (umhos/cm)
North Landfill Zone					
Landfill No. 2	MW-125	7.3/7.3	18.0/16.5	3,300/2,790	3,609/3,330
	MW-126	7.1/6.8	15.0/16.0	6,400/7,030	7,911/8,489
	MW-127	7.7/6.7	17.0/20.0	1,300/13,390	1,534/14,804
	MW-128	7.3/7.5	16.0/20.3	4,400/4,250	5,313/4,669
	MW-129	7.4/7.3	16.0/17.5	2,200/1,820	2,656/2,124
Landfill No. 1	MW-130	7.2/7.2	16.0/18.1	1,500/1,700	1,811/1,958
	MW-230[a]	7.2/7.2	16.0/18.1	1,500/1,700	1,811/1,958
FTA-3	MW-131	7.4/7.2	17.0/17.1	5,000/4,220	5,902/4,970
	MW-132	7.3/7.2	19.0/19.8	5,300/4,580	5,986/5,084
FTA-2	MW-133	7.4/7.3	17.0/15.3	1,600/1,100	1,889/1,350
	MW-134	7.4/7.4	17.0/17.5	2,000/1,570	2,360/1,832

[a]Duplicate sample.

WESTON

Table 3-6

Travis Air Force Base
Fairfield, California
Field Measurements -- March/May 1985

Area/Zone	Staff Gauge or Monitor Well No.	pH (units)	Temperature (°C)	Specific Conductivity (umhos/cm)	Specific Conductivity Corrected to 25°C (umhos/cm)
Landfill No. 3	MW-113	6.5/7.2	18.4/19.3	855/847	978/951
	MW-114	6.5/7.4	18.5/18.6	570/529	651/603
	MW-115	7.2/7.2	17.0/17.5	441/464	521/542
	MW-215[a]	7.2/7.6	17.0/17.5	441/429	521/500
JP-4 Spill	MW-116	7.1/7.0	19.6/19.9	2,200/1.980	2,453/2,194
	MW-216[a]	7.1/7.1	19.6/19.4	2,200/1,970	2,453/2,206

[a]Duplicate sample.

WESTON

Table 3-7

Travis Air Force Base
Fairfield, California
Field Measurements -- March/May 1985

Area/Zone	Staff Gauge or Monitor Well No.	pH (units)	Temperature (°C)	Specific Conductivity (umhos/cm)	Specific Conductivity Corrected to 25°C (umhos/cm)
FTA-4	MW-117	8.1/7.0	16.0/19.1	2,800/2,590	3,381/2,919
	MW-118	7.4/6.7	17.0/18.7	4,200/4,960	4,958/5,638
	MW-119	7.4/7.1	16.0/20.0	1,600/3,490	1,932/3,858
	MW-120	7.2/6.9	19.0/20.2	3,600/3,500	4,066/3,853
	SG-13	8.7/8.2	19.5/22.0	32,500/1,107	36,313/1,174[b]
	SG-14	8.5/8.3	19.5/22.0	31,200/1,203	34,860/1,276[b]
	SG-314[a]	8.5/8.3	19.5/28.2	31,200/1,174	34,860/1,106[b]
	SG-15	8.6/8.6	19.0/23.0	29,600/1,185	33,431/1,232[b]
Sewage Treatment Plant Zone	MW-121	7.2/7.3	15.9/20.6	1,400/1,550	1,695/1,692
	MW-122	7.3/7.6	16.0/20.2	1,315/1,570	1,588/1,729
	MW-123	7.1/6.9	17.0/20.1	3,900/3,380	4,603/3,729
	MW-223[a]	7.1/6.7	17.0/19.3	3,900/3,500	4,603/3,928
	MW-124	7.2/6.7	17.0/20.1	6,700/10,860	7,908/1,198
	MW-125	7.3/7.3	18.0/16.5	3,300/3,790	3,809/3,331
	SG-10	8.3/8.2	17.0/20.0	38,900/1,142	45,915/1,263[b]
	SG-11	8.7/8.3	19.0/21.0	33,900/1,159	38,288/1,255[b]
	SG-12	8.8/8.3	20.0/22.0	33,700/1,161	37,258/1,232[b]

[a]Duplicate sample.
[b]Gross differences in conductivity due to rainfall prior to sampling.

WESTON

3.2.3.5 Surface-Water and Sediment Sampling

A total of 19 staff gauges were established throughout the Storm Sewer Zone and along Union Creek. Thirteen staff gauges were established as part of the Storm Sewer Zone investigation (SG-1 through SG-9, SG-16 through SG-18), three as part of the Sewage Treatment Plant Zone (SG-10 through SG-12) investigation, and three as part of the Fire Training Area No. 4 (SG-13 through SG-15) investigation. Staff gauge locations are depicted in Figures 3-3, 3-5, and 3-12. Surface-water samples were taken directly from Union Creek. Samples from the storm drains were taken by lowering a Teflon bailer into the storm sewer.

At 11 locations along Union Creek (SG-1, SG-9 through SG-18) sediment samples were collected for analysis for oil and grease and volatile organic compounds. The sediment samples were taken by driving a decontaminated split-spoon sampler lined with brass tubes into the stream bottom. Approximately 1 foot of sample was collected, the tubes were sealed with a Teflon-liner and plastic cap, and placed on ice for transportation to the laboratory. Due to the noncohesiveness and water content of the 0 to 4-inch interval, samples were not recoverable from this interval. The sample containers were packaged and handled in the same manner as the water samples, as outlined in Appendix H.

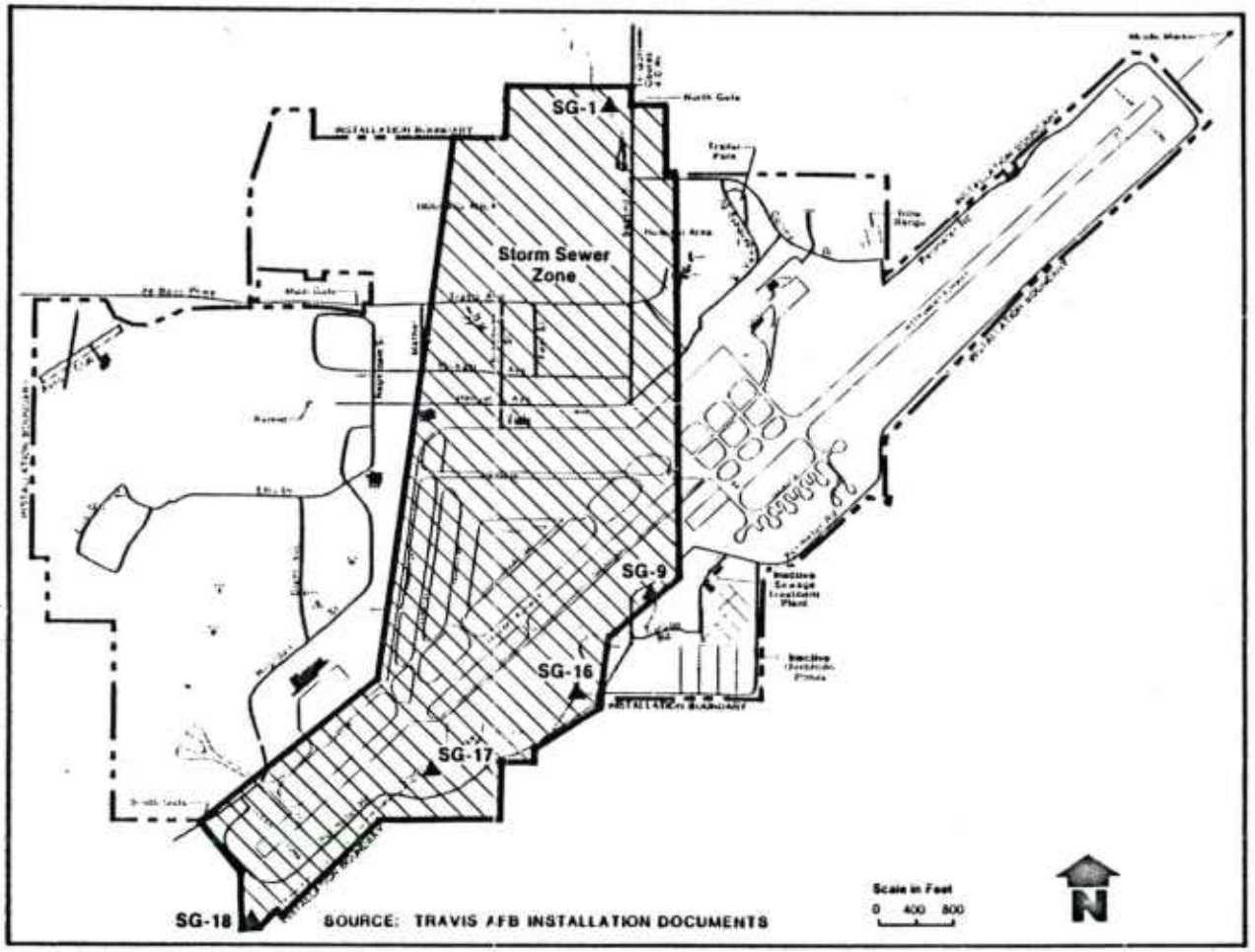


FIGURE 3-12 OTHER STAFF GAUGES IN THE STORM SEWER ZONE

SECTION 4

RESULTS AND CONCLUSIONS

4.1 INTERPRETIVE GEOLOGY

A generalized description of the shallow subsurface beneath Travis AFB can be derived from the boring logs for the 34 monitoring wells installed during Stage 1. The total drilled depths in the monitoring wells ranged from 29.5 to 56.5 feet. The wells penetrated the Recent and Pleistocene age alluvium described in Section 2.

The shallow stratigraphy beneath Travis AFB is not easily divided into discrete layers. In general, the upper 15 to 30 feet consist of silty clays and clayey silts with varying amounts of sand. Within the silts and clays, irregular lenses of sand are found; in some cases, these sand lenses contain water. The silts and clays are generally underlain by silty and clayey sands approximately 10 feet thick. The sands are interbedded with mottled silts and clays. Underlying the silty and clayey sands are more clayey silts and silty clays, some containing fragments of weathered bedrock. Figure 4-1 is a cross-section through Travis AFB, and Figure 4-2 shows the surface trace of the cross-section. The water table generally occurs in perched zones within the sand lenses in the upper silts and clays, or in the sandy layer beneath the silts and clays. During development, the wells yielded between 0.25 gallon/minute and 2.5 gallons/ minute, verifying the low permeabilities of the sediments encountered at the Base.

4.2 GROUNDWATER CONDITIONS

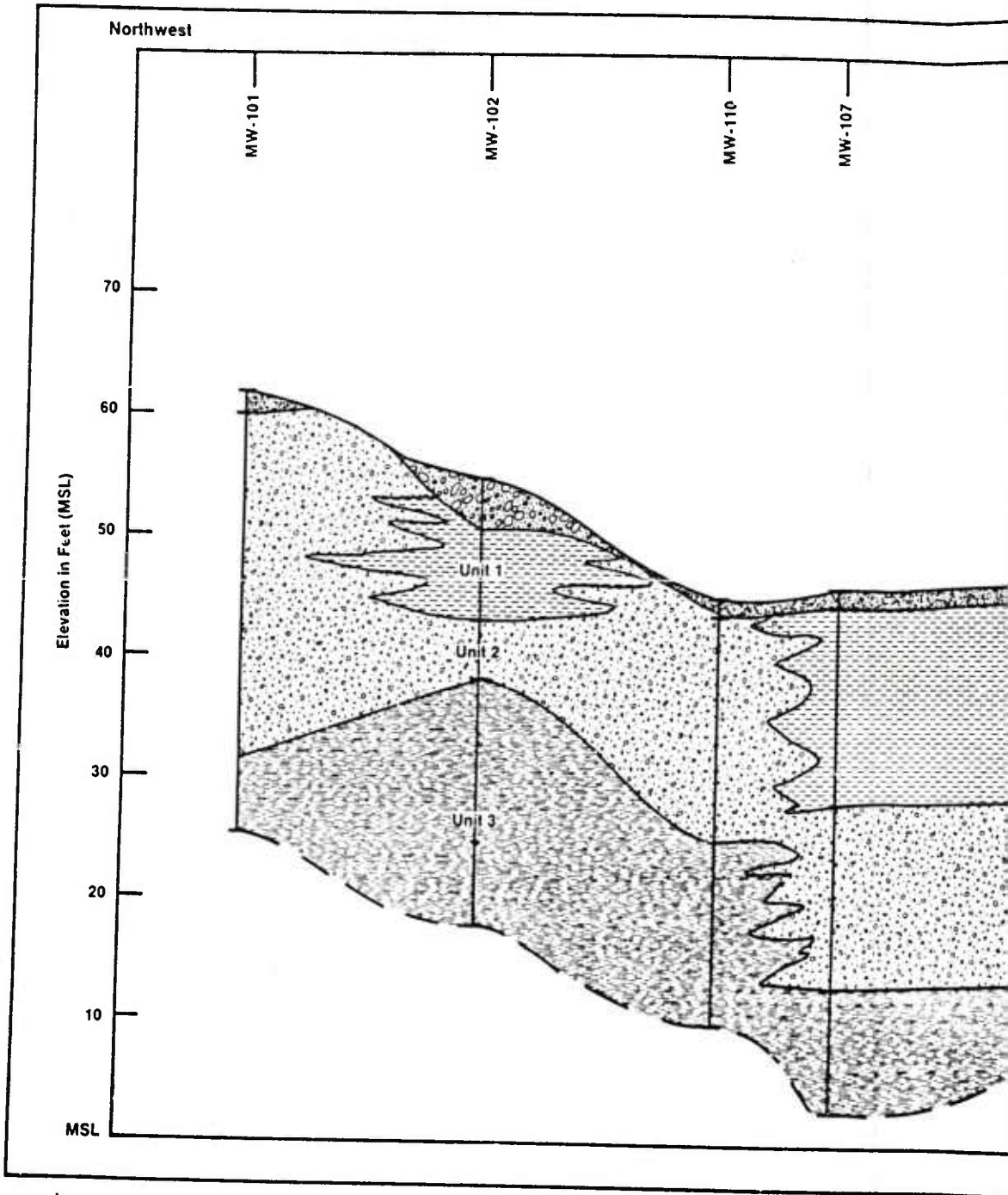
4.2.1 General

The sediments penetrated by the monitoring wells can be considered to represent the upper section of a highly heterogeneous aquifer that is generally unconfined, but in which confined conditions and perched groundwater occur locally. Due to the low permeabilities and lack of utilization of the aquifer in the Base area, the literature referenced has not attempted to define the transmissivity, storativity, and hydraulic conductivities in the area.

Due to the lack of lateral continuity in the sediments, site-specific hydrogeological analyses were not found to be useful in this study. Instead, anomalies in water level hydrographs and water table maps have been used to distinguish specific site characteristics in the general discussions that follow.

4.2.2 Water Level Fluctuations

Groundwater level fluctuations in the shallow aquifer during the period of investigation are presented in the hydrographs in Figure 4-3 through 4-6. These figures are useful in defining the water level trends within specific zones, and evaluating the factors influencing these zones. Water levels in Fire Training Area No. 1 and the Solvent Spill Area (MW-101, MW-104, MW-105, and MW-106) generally rose to a peak in mid-April before steadily declining into May. Water levels in wells in the Oil Spill Area and along the Sewer Right-of-Way (MW-102, MW-103, MW-107, MW-108, MW-111, and MW-112) reached a peak in late March, then declined steadily, with some anomalies, into May. Water levels in MW-109 and MW-110 remained fairly constant throughout the period of investigation. Figure 4-3 illustrates the water level trends in the Storm Sewer Zone.


Northwest
MW-101
MW-102
MW-110
MW-107
70
60
50
40
30
20
10
MSL
Elevation in Feet (MSL)
Unit 1
Unit 2
Unit 3

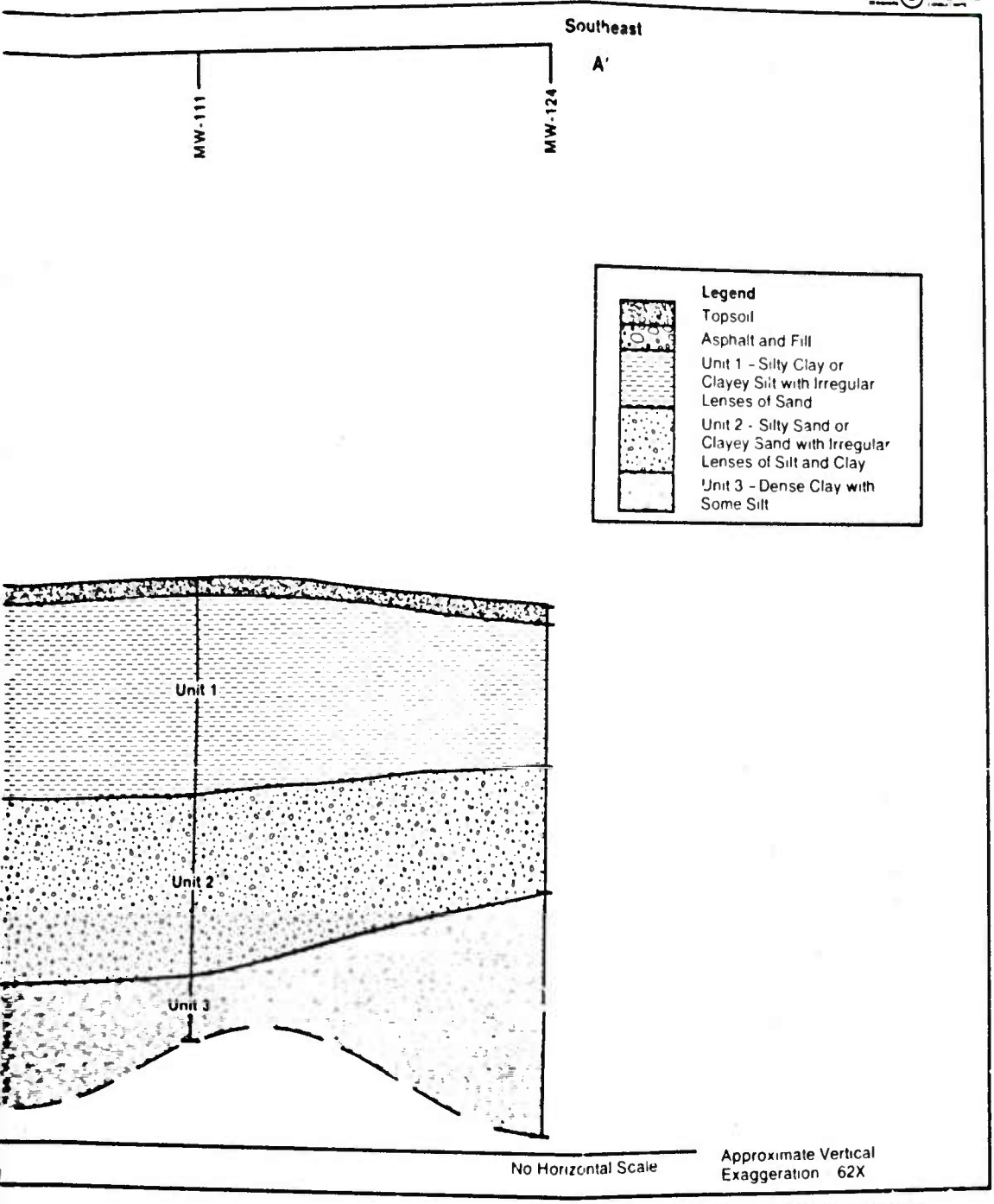


FIGURE 4-1 GENERALIZED STRATIGRAPHIC CROSS-SECTION ACROSS TRAVIS AFB

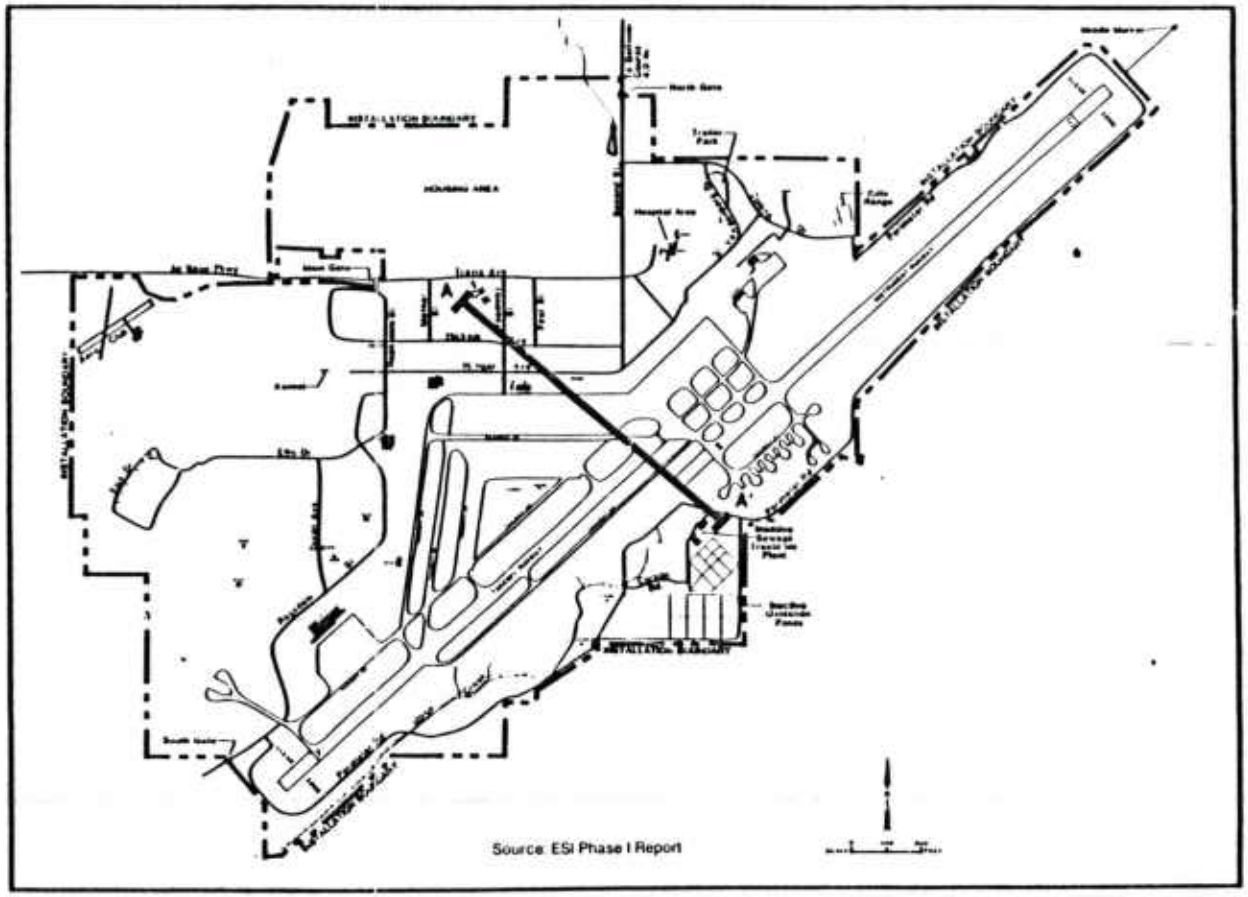


FIGURE 4-2 SURFACE TRACE OF STRATIGRAPHIC CROSS-SECTION

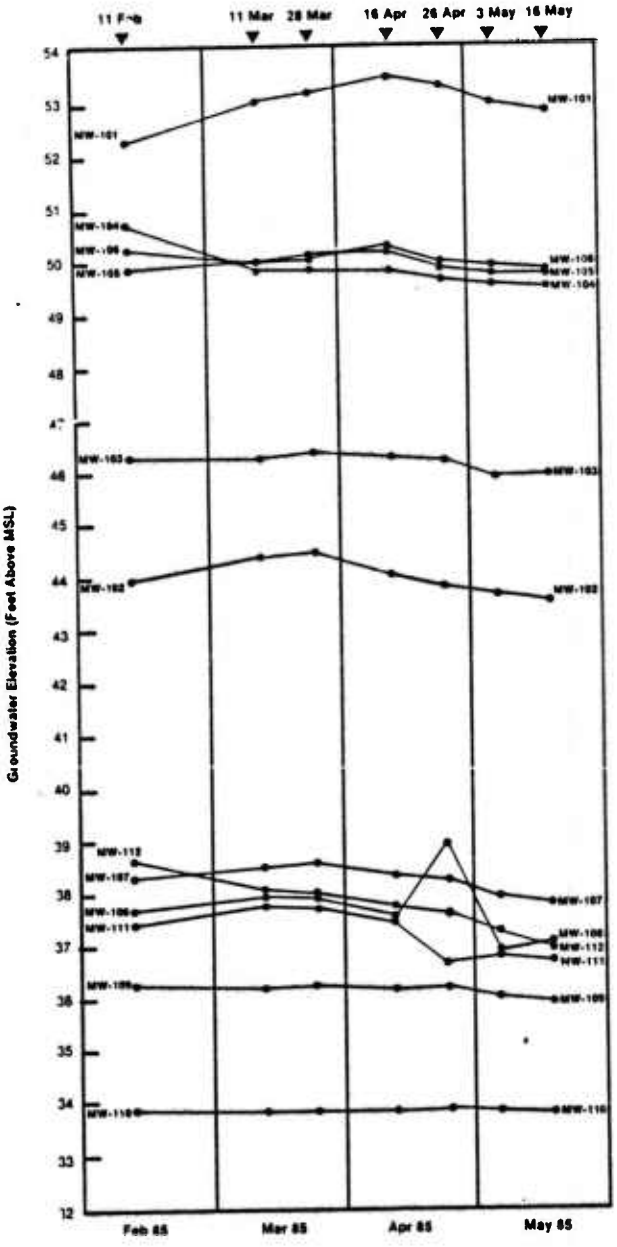


FIGURE 4-3 WELL HYDROGRAPHS - STORM SEWER ZONE

Water levels in Fire Training Area No. 4 (Figure 4-4, wells MW-117 through MW-120) remained fairly constant through February and into mid-March, and started rising steadily in late March. The water levels reached a peak in late April and declined steadily through May. The water levels in MW-117, MW-118, and MW-120, the wells closest to Union Creek, may have been influenced by the influent nature of Union Creek in this area. These three wells showed a sharp rise, while MW-119, the monitoring well farthest from the stream, exhibited a less substantial rise. As noted in Section 2, Union Creek has been observed to rise as much as 4 to 5 feet after a heavy rainfall induced a delayed groundwater level response.

Water levels in monitoring wells MW-121 and MW-122, within the Sewage Treatment Plant Zone, exhibited the same trend as wells within Fire Training Area No. 4, however, the fluctuations were not as pronounced (Figure 4-4). Water levels in MW-123 and MW-124 tend to peak in late March and gradually decline into May. The sharp rise in the water level in MW-124 on 28 March 1985 could be due to a 2-day rainfall prior to this measurement. Although Union Creek is effluent in nature in this area, on the date of measurement, the stream may have been influent at some time during the two days of rain and contributed water to the groundwater system, causing the abrupt rise in the water level in MW-124.

Water levels in the North Landfill Zone areas of Landfills No. 1 and 2 (MW-125 through MW-130) generally remained fairly constant with a decline beginning in late March. Wells MW-125 and MW-126, located behind Landfill No. 2, exhibited a water level rise from February to March, and began declining in late March. A great amount of ponded water was observed around the wells in February and March, indicating saturated soil conditions. The water table occurs at a depth of 2 to 7 feet below ground surface (BGS) in this area. The monitoring wells within Fire Training Area No. 3 (MW-131 and MW-132) exhibited water levels that peaked in mid-April and declined into May; whereas the water levels in MW-133 and MW-134 (Fire Training Area No. 2) peaked in late March, remained fairly constant, and began to decline in late April. These water level fluctuations are depicted in Figure 4-5.

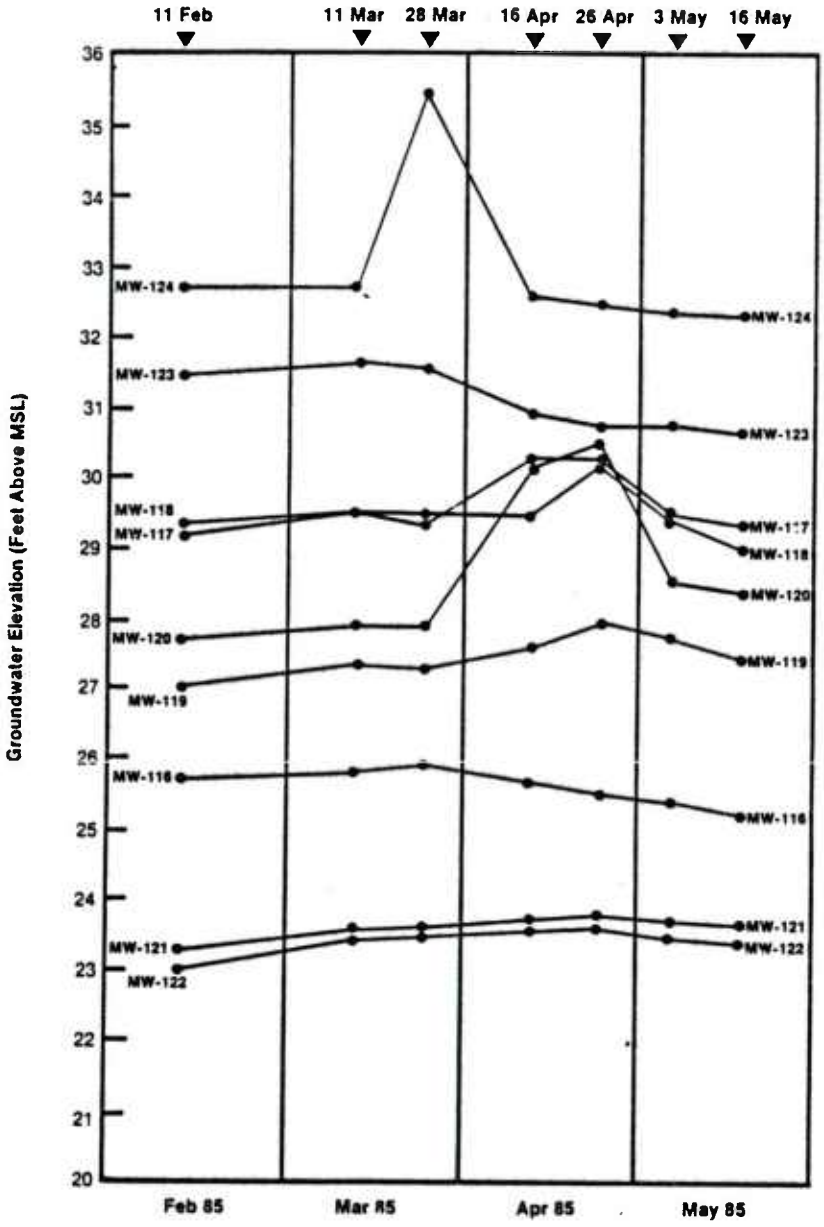


FIGURE 4-4 WELL HYDROGRAPHS - JP-4 SPILL, FIRE TRAINING AREA NO. 4 AND THE SEWAGE TREATMENT PLANT ZONE

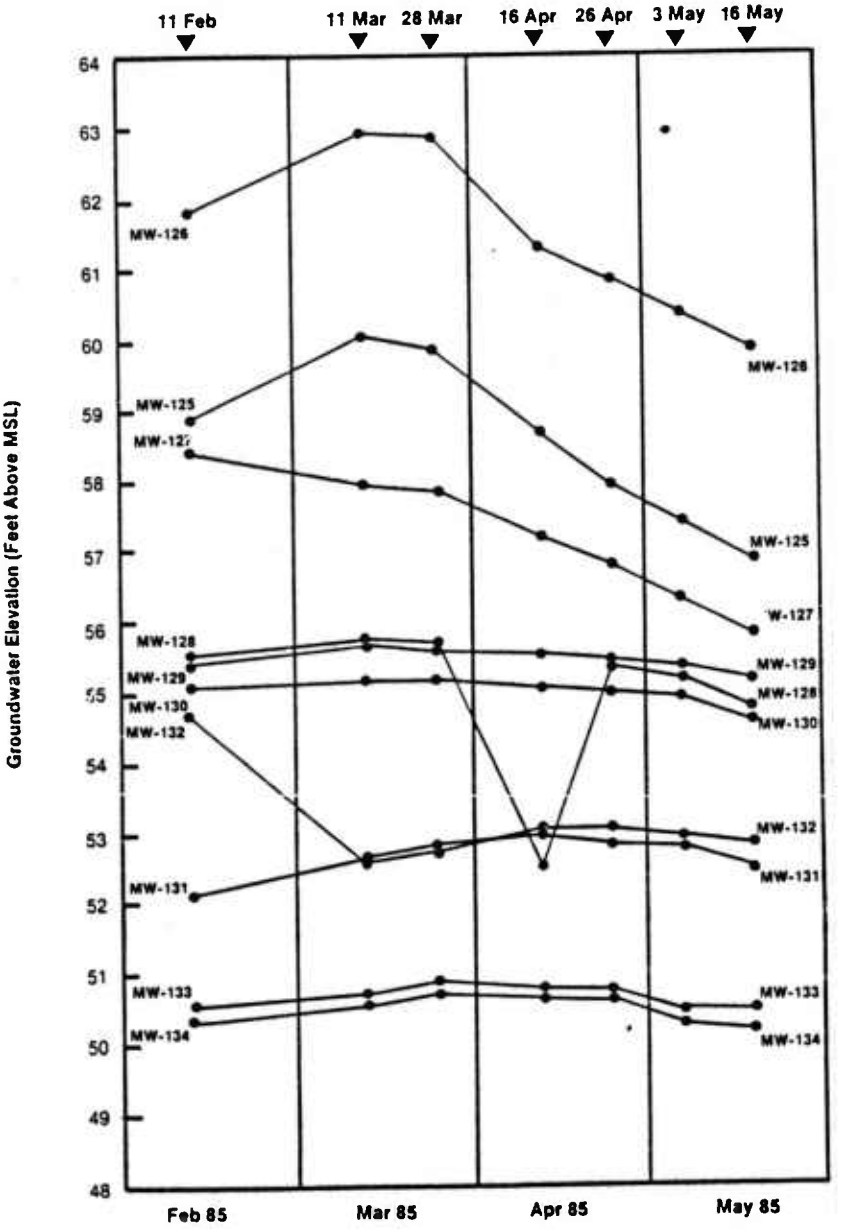


FIGURE 4-5 WELL HYDROGRAPHS
NORTH LANDFILL ZONE

Water levels in monitoring wells MW-113, MW-114, and MW-115 within the Landfill No. 3 area exhibited the most erratic behavior, as depicted in Figure 4-6. The water level in each of these wells peaked at approximately 2-1/2-week intervals. That is, in MW-113, the upgradient well, the water level peaked on 11 March; in MW-114, the water level peaked on 28 March; and in MW-115, the water level peaked on 16 April.

The water level in MW-116 at the JP-4 Spill Site (Figure 4-4) fluctuated very little, with a slight rise in late March and a gradual decline into May.

4.2.3 Groundwater Flow Direction

The groundwater surface maps for the shallow aquifer in Figures 4-7 and 4-8 were developed from water level data collected on 11 March 1984 and 16 May 1985. Storm drain elevations are not included. These figures depict the elevation contours representing the water table surface in the aquifer, or the magnitude of hydraulic head at all points in that aquifer. Groundwater flows from areas of high to areas of low hydraulic head, and in general, the direction of groundwater flow can be considered perpendicular to groundwater level contours. Based on these maps, groundwater generally flows to the south beneath the Base toward Suisun Marsh, although there is variability in flow direction on a site-by-site basis, as described in the subsections that follow.

Differences between the two maps are related primarily to the decline in water levels across the Base in May. Flow direction is essentially the same at both periods of measurement, although the water levels are lower in May than in March.

4.2.4 Site-Specific Groundwater Conditions

This subsection reviews groundwater flow directions in the water table on a site-specific basis. Figures accompanying the discussion illustrate groundwater levels measured on 11 March and 16 May 1985. Tables F-1 through F-7 in Appendix F list the groundwater elevations.

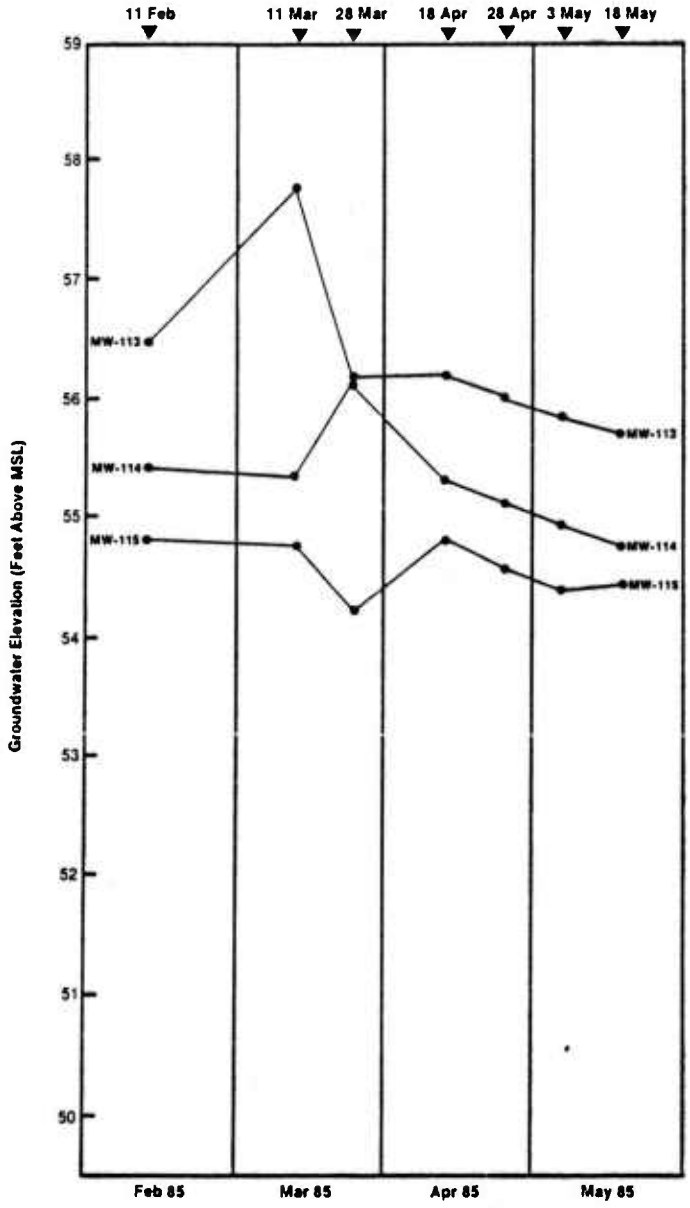


FIGURE 4-6 WELL HYDROGRAPHS - LANDFILL AREA NO. 3

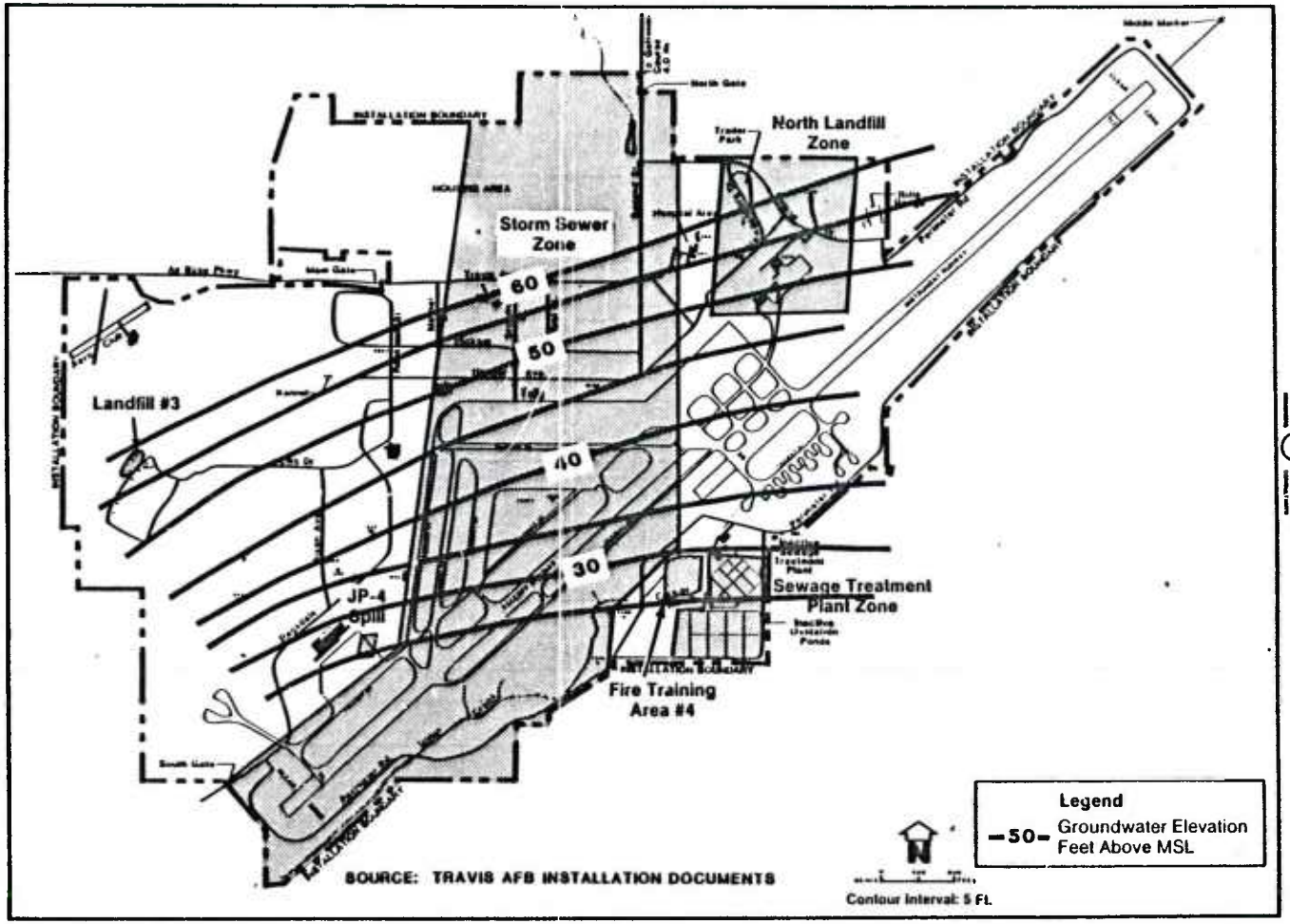


FIGURE 4-7 GROUNDWATER SURFACE MAP FOR TRAVIS AFB - MARCH 1985

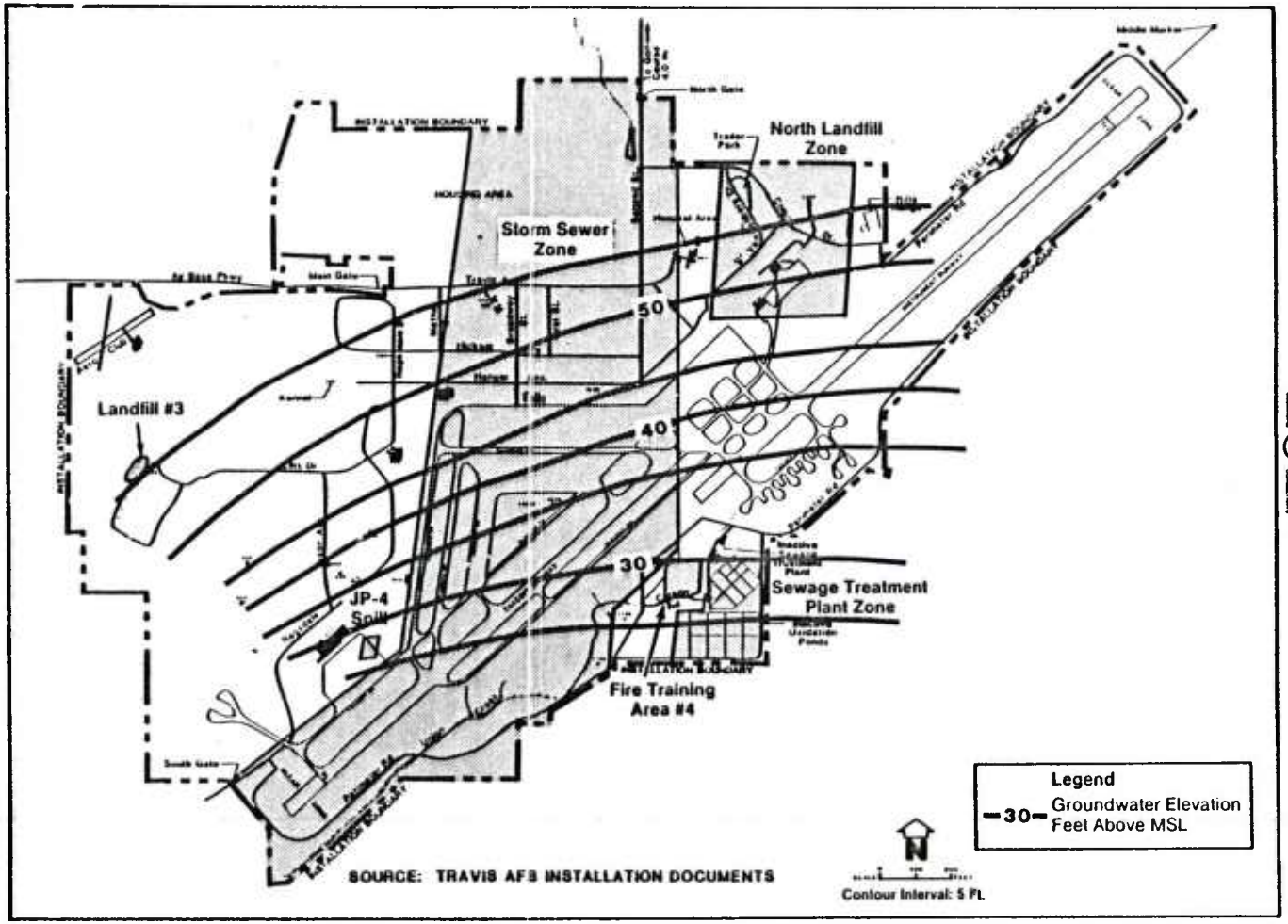


FIGURE 4-8 GROUNDWATER SURFACE MAP FOR TRAVIS AFB - MAY 1985

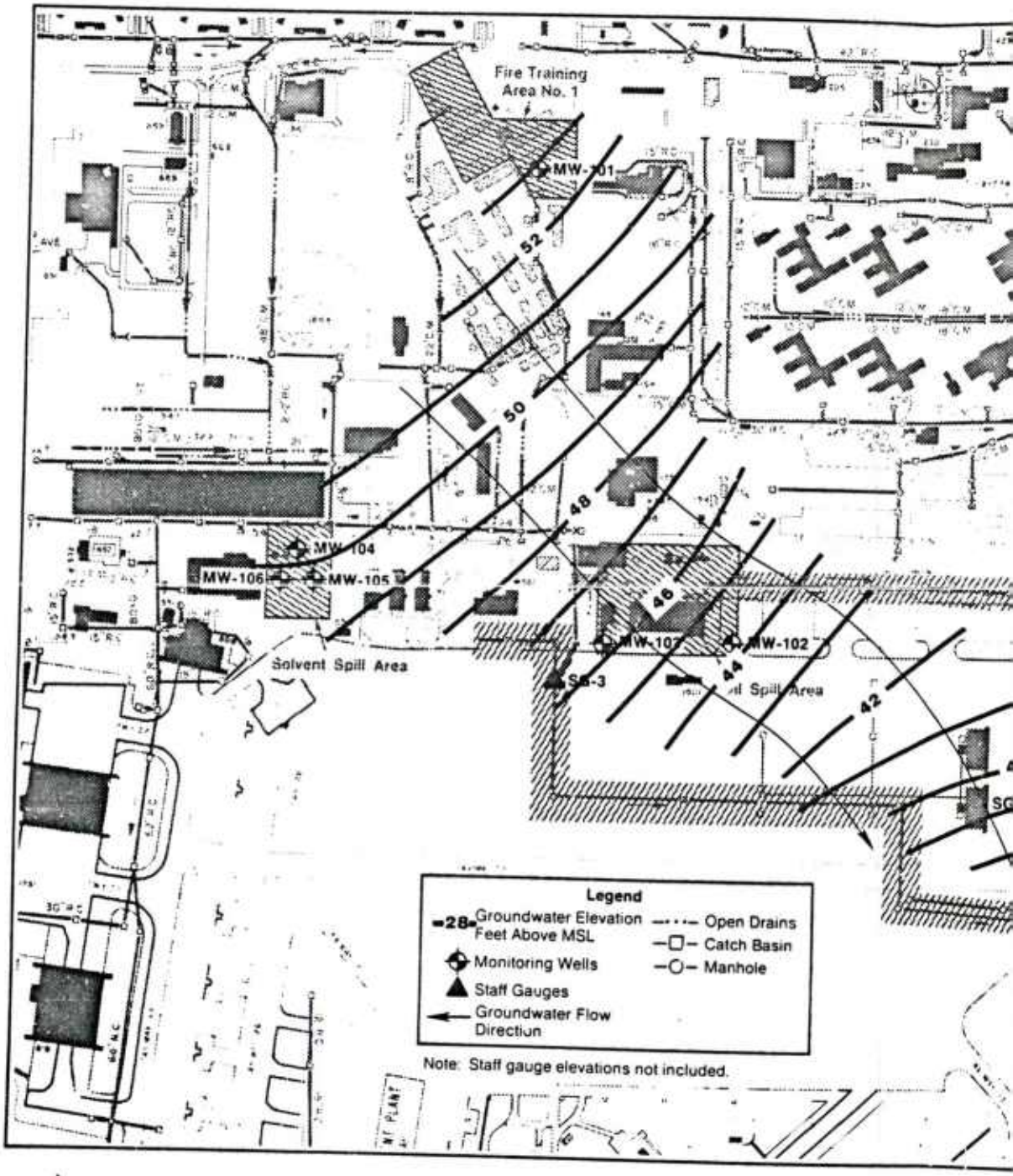
4.2.4.1 Storm Sewer Zone

Groundwater elevations obtained from monitoring wells MW-101 through MW-112 were utilized in developing the groundwater surface maps for the Storm Sewer Zone. Water elevations within the storm drains were not included because the measurements revealed little evidence of correlation between groundwater elevations and storm drain elevations. Within the Storm Sewer Zone, the groundwater flows from a high elevation at MW-101 to a lower elevation at MW-110, generally a southeasterly direction. In the flight line area (MW-107 through MW-112) the groundwater flow direction changes toward the southwest, as depicted in Figures 4-9 and 4-10. Flow directions remain essentially the same in March and May. The rather constant water levels in MW-109 and MW-110 (discussed in Subsection 4.2.2) could be due to interception of groundwater by the storm sewers that run between MW-109 and MW-110, and MW-107 and MW-108.

4.2.4.2 Sewage Treatment Plant Zone and Fire Training Area No. 4

The groundwater surface beneath the Sewage Treatment Plant Zone and Fire Training Area No. 4 is depicted in Figures 4-11 and 4-12. The groundwater in this area flows toward the south and southwest. A slight mounding was evident in Fire Training Area No. 4 in March, which became more pronounced in May. This mounding could be due to the influent nature of Union Creek in this area, i.e., Union Creek has a higher water elevation than the water table, and, therefore, contributes water to the aquifer.

In the Sewage Treatment Plant Zone, no mounding was evident, indicating that the abandoned ponds readily allow water to infiltrate through them into the aquifer. At MW-124, Union Creek is generally effluent, i.e., the water elevation in the stream is lower than the water table, and, therefore, the water table contributes groundwater to the stream. The gradient across the two sites remains fairly constant and equals approximately 0.003 foot/foot.


Fire Training
Area No. 1
MW-101
52
50
48
46
44
42
MW-104
MW-106
MW-105
MW-107
MW-102
SB-3
Solvent Spill Area
Legend
28 Groundwater Elevation Feet Above MSL
Monitoring Wells
Staff Gauges
Groundwater Flow Direction
Open Drains
Catch Basin
Manhole
Note: Staff gauge elevations not included.

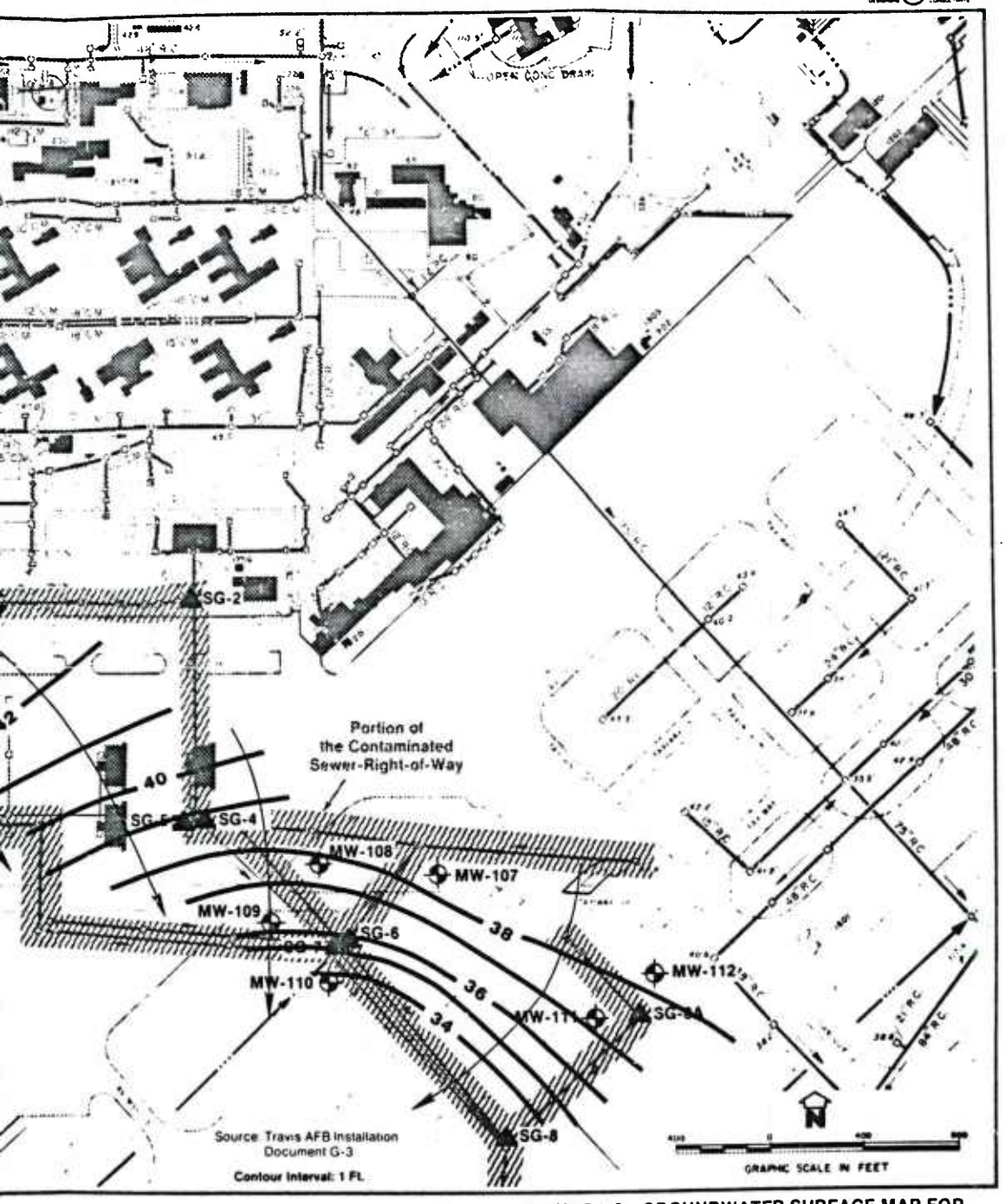
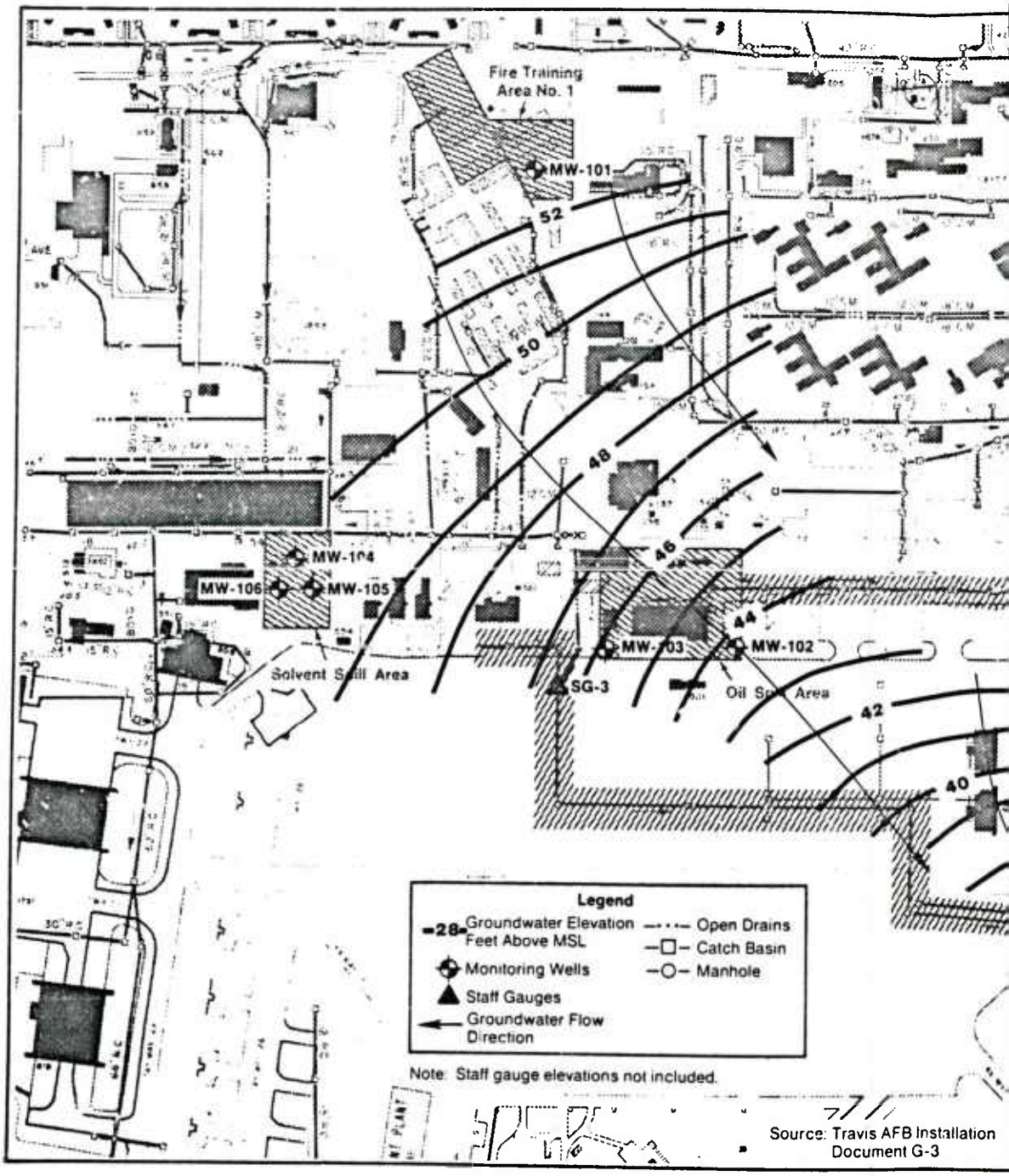


FIGURE 4-9 GROUNDWATER SURFACE MAP FOR THE STORM SEWER ZONE - MARCH 1985



Source: Travis AFB Installation Document G-3

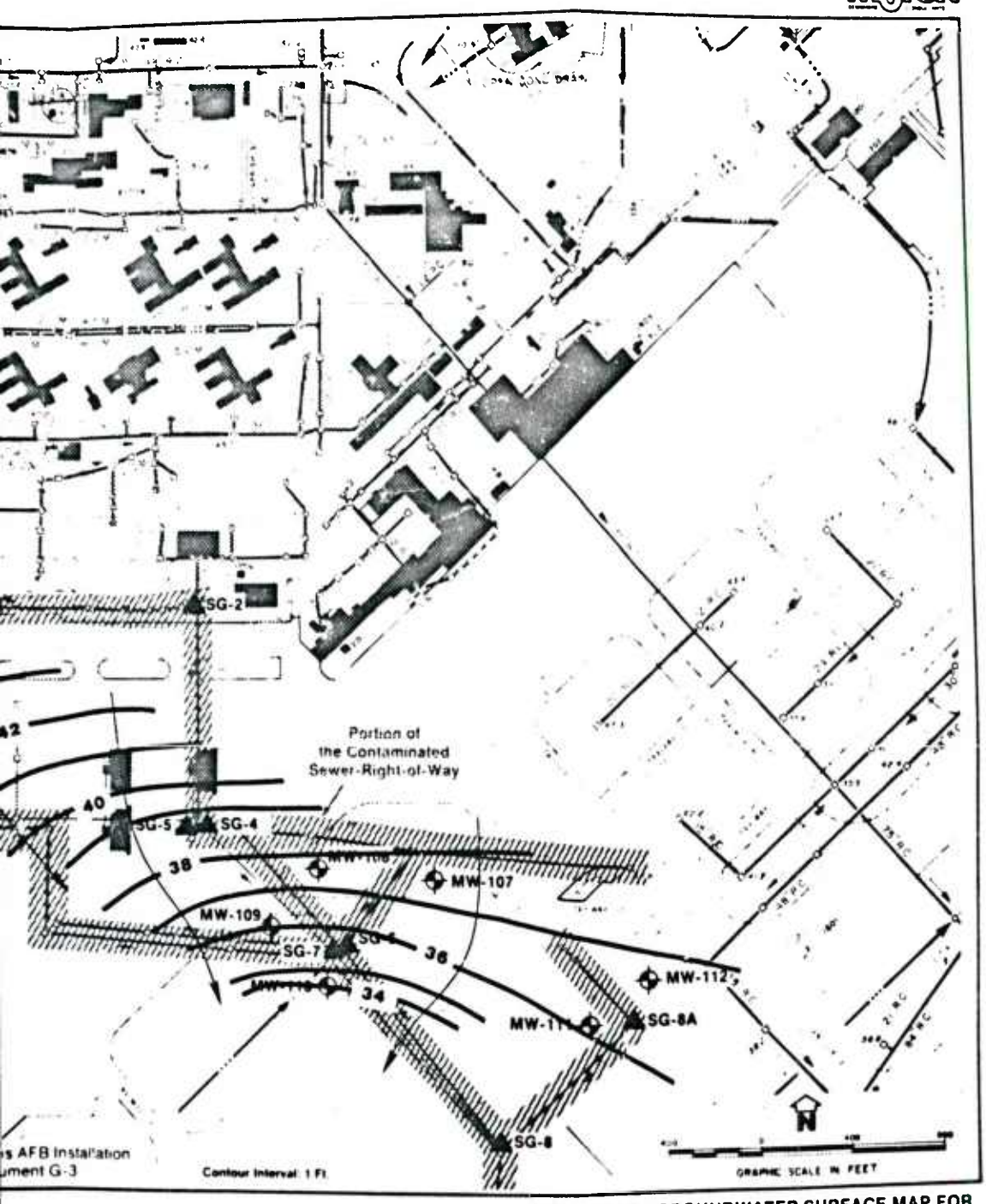


FIGURE 4-10 GROUNDWATER SURFACE MAP FOR THE STORM SEWER ZONE - MAY 1985

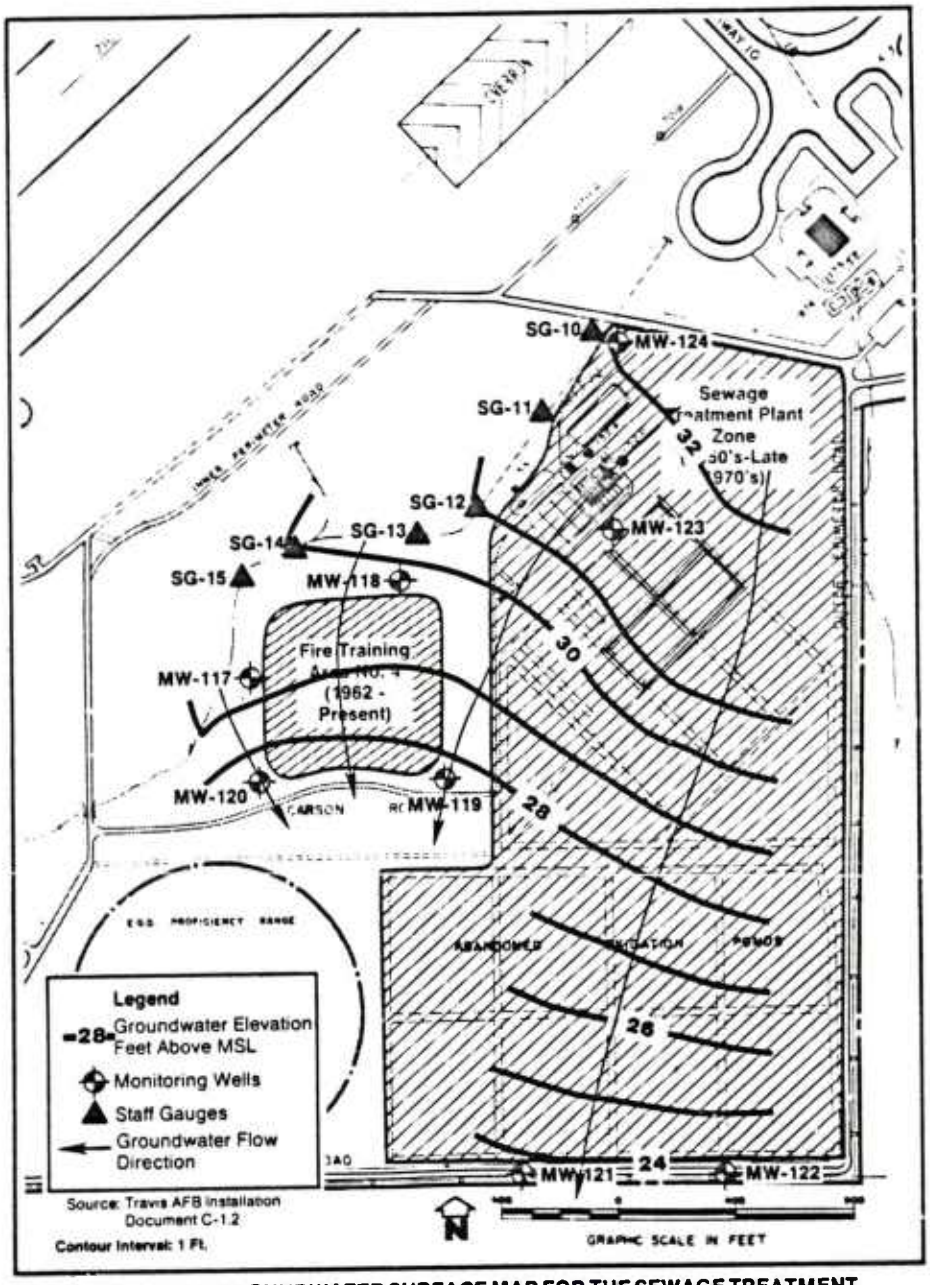


FIGURE 4-11 GROUNDWATER SURFACE MAP FOR THE SEWAGE TREATMENT PLANT ZONE AND FIRE TRAINING AREA NO. 4 - MARCH 1985

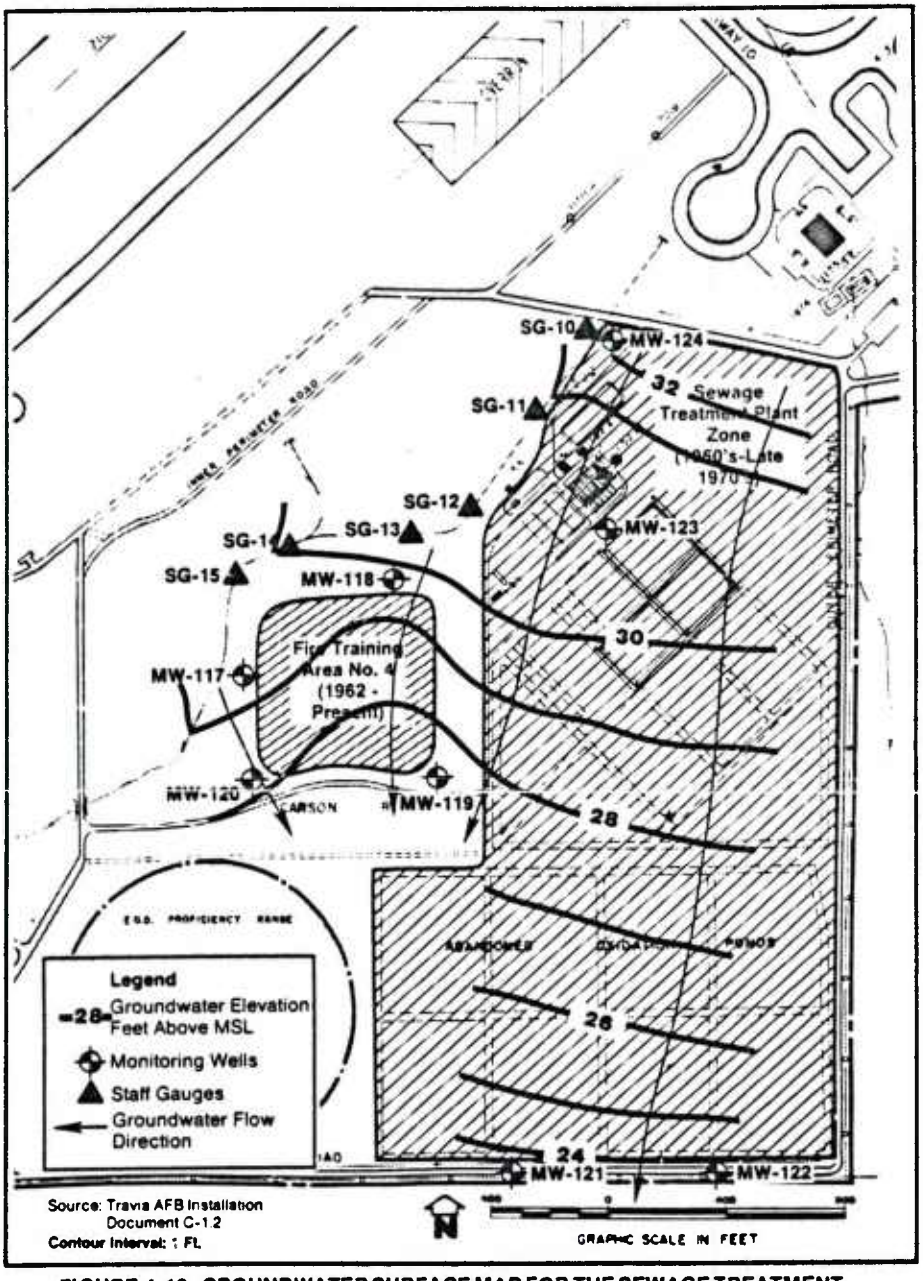


FIGURE 4-12 GROUNDWATER SURFACE MAP FOR THE SEWAGE TREATMENT PLANT ZONE AND FIRE TRAINING AREA NO. 4 - MAY 1985

4.2.4.3 North Landfill Zone

Groundwater surface maps for the North Landfill Zone are depicted in Figures 4-13 and 4-14. Groundwater flow across the area is from the east to southwest. Slight mounding appears across the area toward Landfill No. 2. This mounding could be due to the permeable nature of the materials disposed of in the landfill. In March, when the mounding was more pronounced, ponded surface water was observed throughout the zone, indicating saturated soil conditions and clayey surface soils. The gradient across the site becomes steeper near Fire Training Area No. 3, and varies across the site.

Underflow to the Base from the north and northeast is adequately monitored by wells MW-125 and MW-126 in this area.

4.2.4.4 Landfill No. 3 and the JP-4 Spill Site

The groundwater flow directions for Landfill No. 3 are depicted in Figures 4-15 and 4-16. Only one monitoring well (MW-116) was installed at the JP-4 Spill Site, therefore, groundwater surface maps could not be developed.

Groundwater flow at Landfill No. 3 is toward the southwest. The gradient is fairly flat across the site, equaling approximately 0.006 foot/foot.

Underflow to the Base from the northeast is adequately monitored by MW-113.

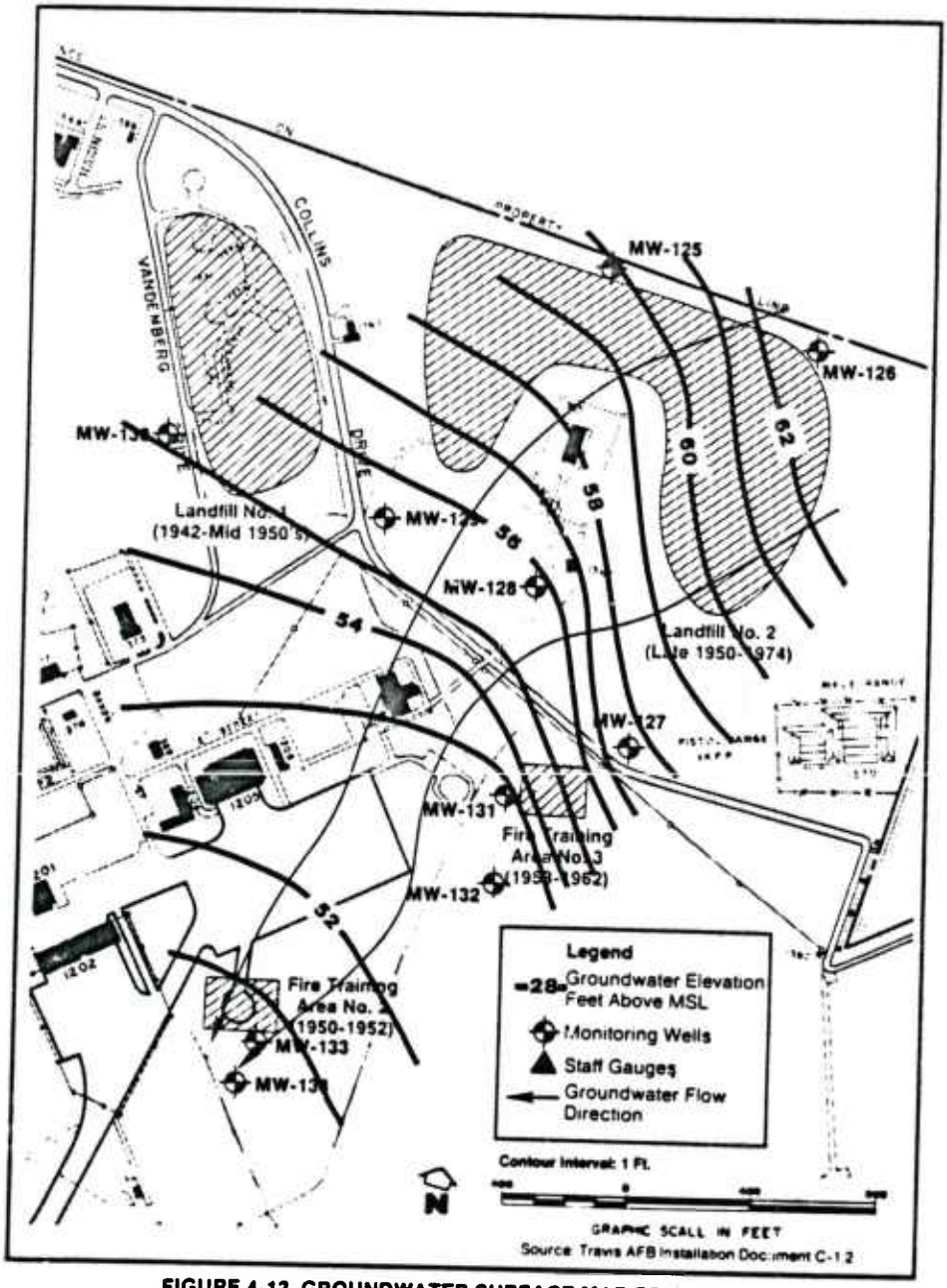


FIGURE 4-13 GROUNDWATER SURFACE MAP FOR THE NORTH LANDFILL ZONE - MARCH 1985

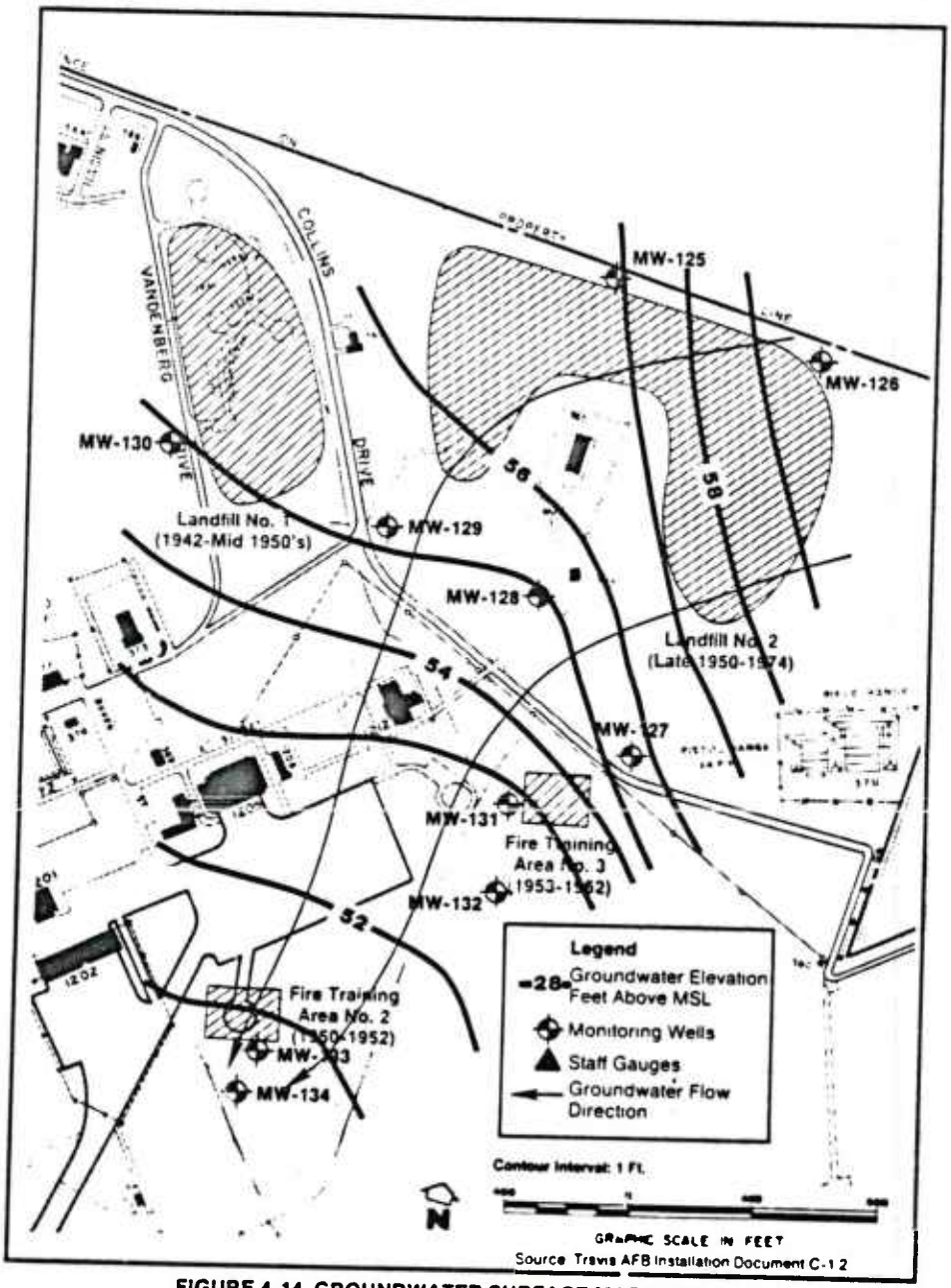


FIGURE 4-14 GROUNDWATER SURFACE MAP FOR THE NORTH LANDFILL ZONE - MAY 1985

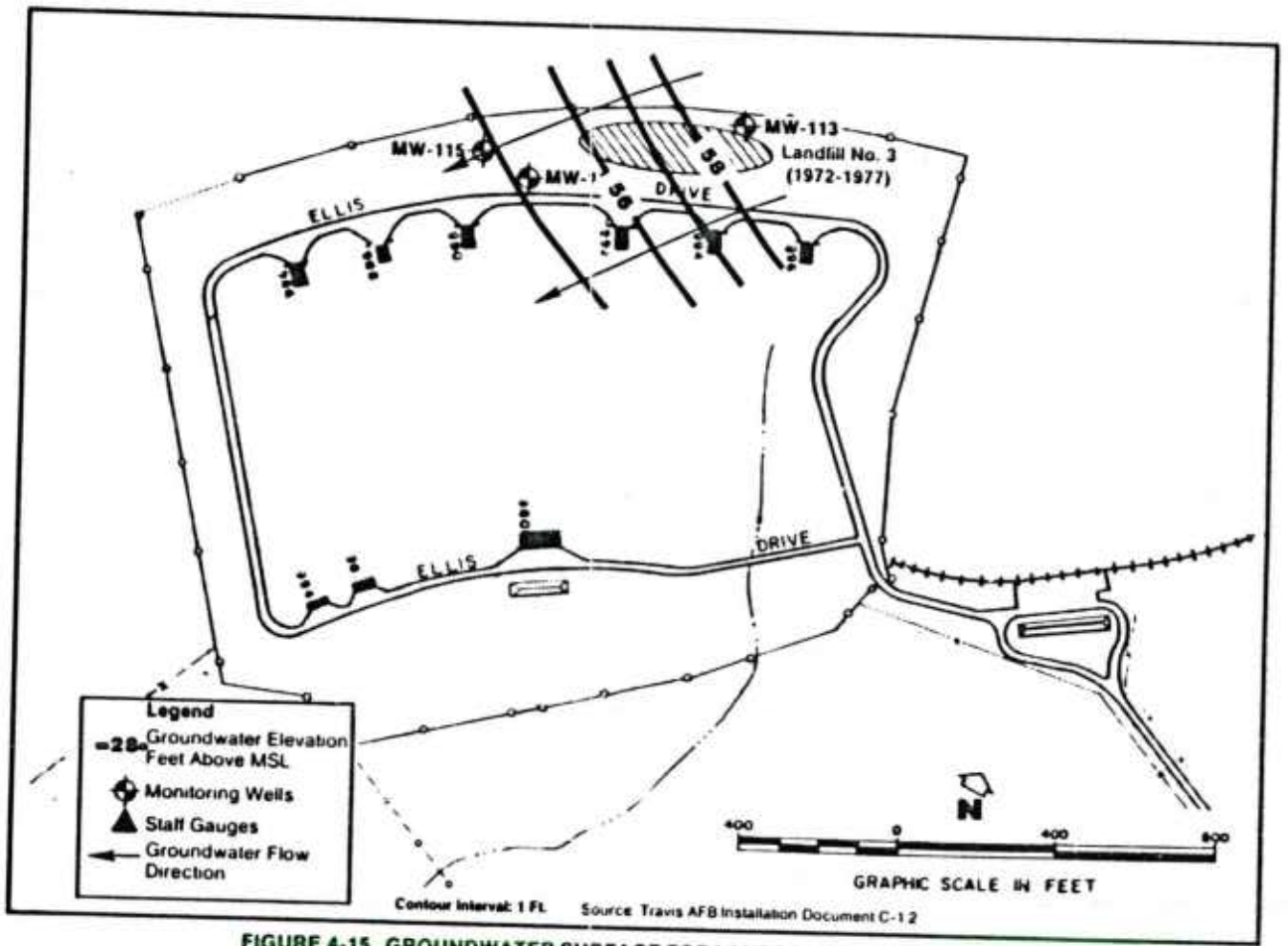


FIGURE 4-15 GROUNDWATER SURFACE FOR LANDFILL NO. 3 - MARCH 1985

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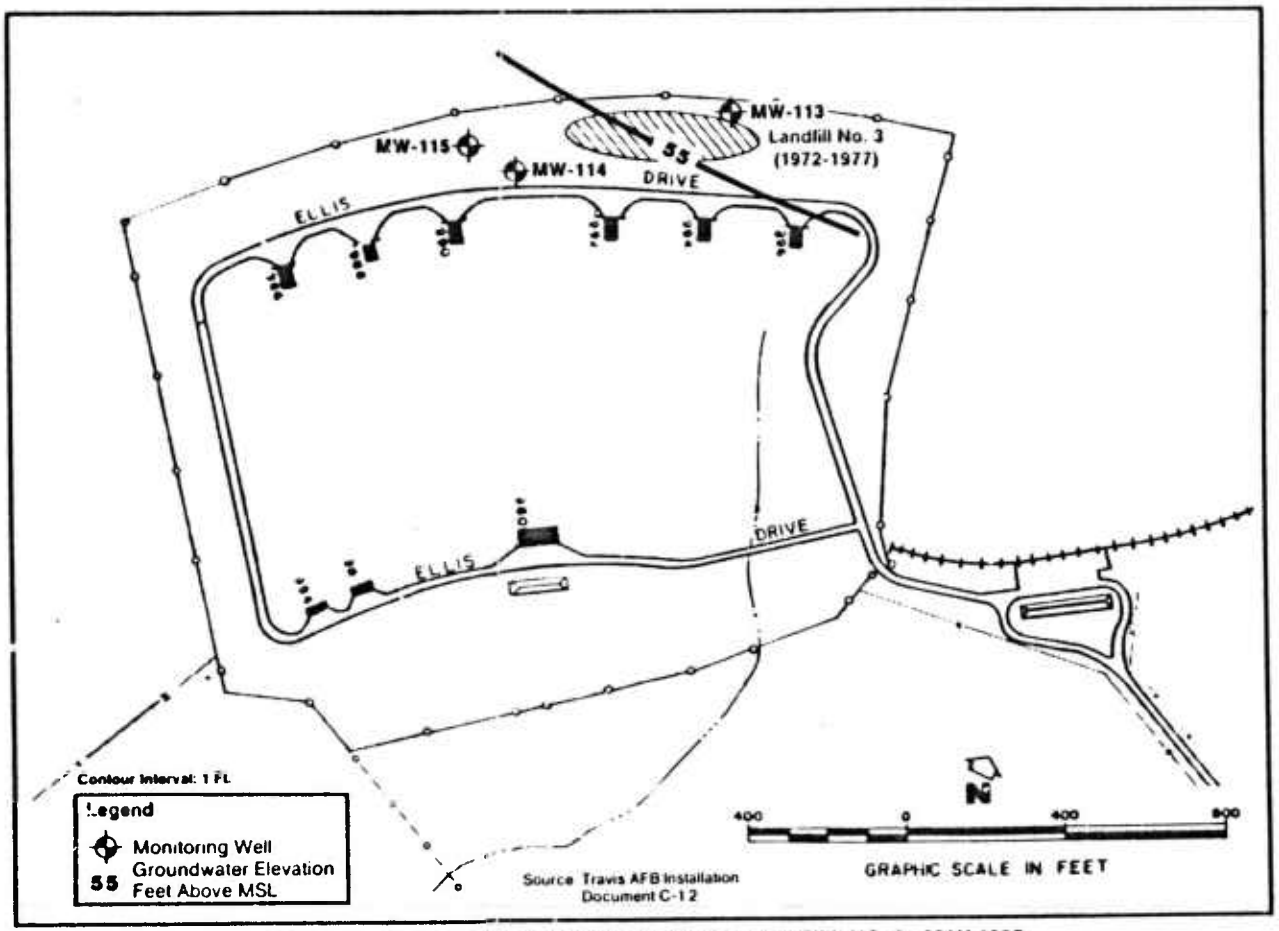

FIGURE 4-16 GROUNDWATER SURFACE FOR LANDFILL NO. 3 - MAY 1985

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4.3 RESULTS OF CHEMICAL ANALYSES OF SOILS AND SEDIMENTS

This subsection reviews chemical data obtained from soil and sediment samples collected at Travis AFB in January and March 1985. The samples collected included surface and shallow subsurface soils, and sediments from the bottom of Union Creek. The methods used in sample collection are described in Section 3. The laboratory methods used in sample analysis are listed in Appendix J. Laboratory analytical reports for soils and sediments are reproduced in Appendix K.

4.3.1 Well Boring Results -- Surface and Shallow Subsurface Soils

Surface and shallow subsurface soils were collected at the locations described below:

- At three sites within the Storm Sewer Zone:
  - Fire Training Area No. 1.
  - Oil Spill Area.
  - Solvent Spill Area.
- At two areas within the North Landfill Zone:
  - Fire Training Area No. 2.
  - Fire Training Area No. 3.

Soils were also collected at Fire Training Area No. 4.

All samples were taken using hollow stem auger drilling techniques and a split-spoon sampler. Samples were collected for analysis from the following intervals:

- 0 to 1.5 feet below ground surface.
- 2.5 to 4 feet below ground surface.
- 5 to 6.5 feet below ground surface.

Due to the volume of sample required for adequate storage, transportation, and analysis, duplicates were collected by redrilling the top 2 feet of soil as close as possible to the original borehole for that sample location. Therefore, variability in duplicate sample results most likely represents heterogeneity in the distribution of the parameters analyzed within very short distances in the surface soil. Analytical results are reviewed on a site-by-site basis in the subsections that follow.

4.3.1.1 Storm Sewer Zone

Twenty-one soil samples, including three duplicates, were taken for chemical analysis for oil and grease or petroleum hydrocarbons, and volatile organics. The results of these analyses are listed in Table 4-1. Only those VOC's that were detected are included. Also included are the HNu readings taken of the collected samples.

4.3.1.1.1 Fire Training Area No. 1

Three samples and one duplicate sample were collected from MW-101 in Fire Training Area No. 1. No VOC's were detected in any of the samples.

Petroleum hydrocarbons were detected in each interval sampled and analyzed. The concentrations ranged from 80 mg/kg to 160 mg/kg. The low concentration occurred in the middle interval (2.5 to 4 feet), and the high concentration occurred at the surface (0 to 1.5 feet). The concentrations did not exhibit any decreasing or increasing pattern with depth. The sediments encountered were very uniform in nature and appeared to be fill material. The fine to medium sands encountered would allow the hydrocarbons to penetrate through the sediments at varying rates causing an uneven distribution of concentrations.

4.3.1.1.2 Oil Spill Area

Six samples and one duplicate were collected from MW-102 and MW-103. At MW-102, the surface sample contained trichloroethene (TCE) at 0.013 mg/kg. Asphalt overlying the sediments was not included in the sample. This monitoring well is located near the Engine Repair Building (Building 16), however, no solvents were used or are currently being used in the building (ESI, 1983). The well is located downgradient of Building 18, the Cleaning and Degreasing Shop, where solvents are utilized regularly. In the past, these solvents were disposed of through the surface drainage system (ESI, 1983).

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Table 4-1

Travis Air Force Base, Fairfield, California
Analytical Results, Soil Samples from Well Borings, January 1985

Zone/Area	Monitor Well and Sample No.	Petroleum Hydrocarbons (mg/kg)	Oil and Grease (mg/kg)	Trichloro-ethene (mg/kg)	HNu Readings (ppm)
Storm Sewer Zone					
FTA-1	MW-101-1	160.	NR	ND	0
	MW-101-1D[a]	80.	NR	ND	0
	MW-101-2	80.	NR	ND	0
	MW-101-3	105.	NR	ND	0
Oil Spill Area	MW-102-1	NR	440.	0.013	0
	MW-102-2	NR	135.	ND	0
	MW-102-3	NR	105.	ND	0
	MW-103-1	NR	4,500.	ND	0
	MW-103-1D[a]	NR	5,500.	ND	0
	MW-103-2	NR	600.	ND	0
	MW-103-3	NR	230.	ND	0
Solvent Spill Area	MW-104-1	NR	185.	ND	0
	MW-104-1D[a]	NR	80.	ND	0
	MW-104-2	NR	185.	ND	0
	MW-104-3	NR	300.	ND	0
	MW-105-1	NR	295.	ND	0
	MW-105-2	NR	265.	ND	0
	MW-105-3	NR	550.	0.014	0
	MW-106-1	NR	280.	0.017	0
	MW-106-2	NR	300.	ND	0
	MW-106-3	NR	320.	ND	0
	Detection limit	0.005	0.001	0.0001	0

[a]Duplicate sample.
ND - Not detected.
NR - Not requested.

Sample 1 -- 0 to 1.5 feet
Sample 2 -- 2.5 to 4 feet
Sample 3 -- 5 to 6.5 feet

Note: Only volatile organics detected are listed.

Oil and grease were detected in all samples analyzed from MW-102 and MW-103. The highest concentrations in each well (MW-102-1 = 440 mg/kg, MW-103-1 = 4,500 mg/kg) were found in the surface samples. Again, the asphalt overlying these sediments was not included in the sample. The concentrations of oil and grease decrease with depth. The higher concentrations in MW-103 samples could probably be attributed to its proximity to the Cleaning and Degreasing Shop, where, in the past, waste oils and fuels were disposed of through the surface drainage system.

4.3.1.1.3 Solvent Spill Area

In the Solvent Spill Area, nine samples and one duplicate were collected for analysis. TCE was detected in two samples; MW-105-3 at 0.014 mg/kg and MW-106-1 at 0.017 mg/kg. Asphalt overlying the sediments at MW-106 was not included in the sample.

Oil and grease was detected in all samples, and the concentrations, ranging from 80 mg/kg (duplicate MW-104-1D) to 550 mg/kg (MW-105-3), increased with depth. The highest oil and grease concentrations were found at the 5- to 6.5-foot interval in each boring. This increase with depth can most easily be explained by the heterogeneity of the shallow subsurface sediments, as discussed in earlier sections of this report. In areas where shallow low-permeability layers such as clay are found, hydrocarbon compounds would be expected to be retained in the shallow soil horizons. In localities where more permeable sands and silts are found at the surface, the hydrocarbon compounds would be expected to be carried deeper into the soil profile.

4.3.1.2 Fire Training Area No. 4

The results of the analyses for Fire Training Area No. 4 are included in Table 4-2. A total of 12 samples, including one duplicate, were collected for analysis from boreholes within FTA-4. Of the 32 priority pollutant volatile compounds analyzed, none were detected in any of the samples.

Petroleum hydrocarbons were detected in all samples. The highest concentration was found at the 0- to 1.5-foot interval at MW-118, (16,000 mg/kg). At this location the concentrations decreased with depth. MW-118 is located in a drainage way leading from Fire Training Area No. 4 where waste fuels are presently, and were in the past, utilized for fire training exercises. The next highest concentration was found in the 0- to 1.5-foot interval at MW-120, equaling 9,000 mg/kg. This well is located near the above-ground storage tank utilized to hold the waste fuels. Concentrations at MW-120 decreased with depth.

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Table 4-2

Travis Air Force Base, Fairfield, California
Analytical Results, Soil Samples from Well Borings, January 1985

Zone/Area	Monitor Well and Sample No.	Petroleum Hydrocarbons (mg/kg)	Trichloro-ethene (mg/kg)	HNu Readings (ppm)
FTA-4	MW-117-1	2,600.	ND	2
	MW-117-2	4,950.	ND	--[a]
	MW-117-3	195.	ND	--[a]
	MW-118-1	16,000.	ND	60
	MW-118-2	3,000.	ND	50
	MW-118-3	95.	ND	0
	MW-119-1	100.	ND	0
	MW-119-2	80.	ND	0
	MW-119-3	115.	ND	0
	MW-120-1	9,000.	ND	0
	MW-120-1D[b]	8,000.	ND	0
	MW-120-2	8,000.	ND	0
North Landfill Zone				
FTA-3	MW-131-1	145.	ND	0
	MW-131-2	110.	ND	0
	MW-131-3	9,500.	ND	0
	MW-132-1	185.	ND	0
	MW-132-2	800.	ND	0
	MW-132-3	6,500.	ND	0
FTA-2	MW-133-1	385.	0.0038	0
	MW-133-1D[b]	1,100.	0.0021	0
	MW-133-2	175.	ND	0
	MW-133-3	305.	ND	0
	MW-134-1	140.	ND	0
	MW-134-2	235.	ND	0
	MW-134-3	230.	ND	0
	Detection limit	0.005	0.001	0

[a]Instrument nonfunctional.
[b]Duplicate sample.
ND - Not detected.

Sample 1 -- 0 to 1.5 feet
Sample 2 -- 2.5 to 4 feet
Sample 3 -- 5 to 6.5 feet

At location MW-117, the highest petroleum hydrocarbon concentration (4,950 mg/kg) was found in the 2.5- to 4-foot interval. At MW-119 the highest concentration occurred in the 5- to 6.5-foot interval at 115 mg/kg. This variability in the vertical distribution of petroleum hydrocarbons is due to the lateral discontinuity of the sediments.

Although the HNu did respond at samples MW-117-1, MW-118-2, and MW-118-3, there was no correlation between the readings and the analytical results.

4.3.1.3 Sewage Treatment Plant Zone

Although split-spoon samples were taken from borings in the Sewage Treatment Plant Zone (STPZ), the samples were not scheduled for chemical analysis. However, the Task Order allows for up to eight samples to be analyzed for EP toxicity and ignitability testing for hazardous waste determination.

At boring MW-123 the HNu detected organic vapors at 500 ppm in the sample from the 0- to 1.5-foot interval. The WESTON geologist supervising the drilling interpreted this concentration as emanating from a potentially hazardous material. The sample was tested for EP toxicity and ignitability, and the results are presented in Table 4-3. These results indicate that the sample is nonhazardous. No other samples were taken for EP toxicity and ignitability testing at any other location on the Base.

4.3.1.4 North Landfill Zone

A total of 13 samples including one duplicate were collected for analysis from Fire Training Areas Nos. 2 and 3 within the North Landfill Zone. The samples were collected for analysis of petroleum hydrocarbons and volatile organics.

Table 4-3

Travis Air Force Base, Fairfield, California
EP Toxicity and Ignitability Results, MW-123-1

Parameter	EP Toxicity Results Concentration (mg/L)	Maximum Allowable Concentration[a] (mg/L)	Detection Limit (mg/L)
Arsenic	ND	5.0	0.005
Barium	ND	100.0	0.1
Cadmium	ND	1.0	0.01
Chromium	0.05	5.0	0.05
Mercury	ND	0.2	0.005
Lead	ND	5.0	0.1
Selenium	ND	1.0	0.005
Silver	0.05	5.0	0.01
Endrin	ND	0.02	0.02
Lindane	ND	0.4	0.04
Methoxychlor	ND	10.0	10.
Toxaphene	ND	0.5	0.5
2,4-D	ND	10.0	10.
2,4,5-TP	ND	1.0	1.

Ignitability Results

The sample did not exhibit the characteristics of ignitability as defined in 40 CFR 261.21.

[a]A sample is considered hazardous if the extract from that sample contains any of the above at a concentration equal to or exceeding the maximum concentration (40 CFR 261.24).

ND -- Not detected.

4.3.1.4.1 Fire Training Area No. 2

Six samples and one duplicate were collected at Fire Training Area No. 2 (FTA-2). Of the 32 priority pollutant volatile organics analyzed, trichloroethene (TCE) was the only VOC detected. The TCE was found in the 0- to 1.5-foot interval at MW-133 and its duplicate. The concentrations found were 0.0038 mg/kg and 0.0021 mg/kg, respectively. MW-133 is located closest to the concrete pad now covering the former fire training area. Solvents were utilized at FTA-2 when it was active and may have been washed into this area during training exercises.

Petroleum hydrocarbons were detected in all samples. At MW-133 the highest concentration occurred in the duplicate MW-133-1D, at 1,100 mg/kg. The original sample concentration was 385 mg/kg. Within the borehole the highest concentration occurred in the 0- to 1.5-foot interval at 385 mg/kg. The petroleum hydrocarbon concentrations decreased to 175 mg/kg in the 2.5- to 4-foot interval, then increased to 305 mg/kg in the 5- to 6.5-foot interval. At MW-134 the lowest concentration occurred at the surface, equaling 140 mg/kg and increasing to 235 mg/kg and 230 mg/kg in the subsequent intervals. Again, this variability in the vertical distribution is most likely due to the heterogeneity of the shallow subsurface sediments.

4.3.1.4.2 Fire Training Area No. 3

Six samples were collected from the boreholes in Fire Training Area No. 3 (FTA-3). No volatile organics were detected.

Petroleum hydrocarbons were found in all of the samples from FTA-3. The highest concentrations were found in the 5- to 6.5-foot interval at MW-131 and MW-132; concentrations were 9,500 mg/kg and 6,500 mg/kg, respectively. The concentrations generally increased with depth.

4.3.2 Union Creek Sediment Results

Sediment samples were taken at 11 staff gauge locations along Union Creek (SG-1, SG-9 through SG-18). Duplicate samples were taken at two of the locations. Figures 3-3, 3-5, and 3-12 depict the staff gauge location samples. The samples were analyzed for volatile organic compounds and oil and grease. The methods for sample collection are described in Subsection 3.2.3.5.

4.3.2.1 Storm Sewer Zone

Of the 32 priority pollutant volatile organics analyzed, five were detected in stream sediments from only one location in the Storm Sewer Zone. The results are presented in Table 4-4. Sample location SG-9 sediments contained detectable concentrations of tetrachloroethene, chlorobenzene, 1,4-dichlorobenzene, toluene, and ethylbenzene. The concentrations of VOC's ranged from 0.0012 to 3.4 mg/kg, with 1,4-dichlorobenzene having the lowest concentration and ethylbenzene having the highest. Only toluene and ethylbenzene were detected in both intervals sampled.

At location SG-9 an oil-like sheen was noticeable on the water surface. SG-9 is located at a point where the storm sewer system empties into Union Creek. The presence of toluene and ethylbenzene indicates the dissolved portion of the floating hydrocarbons are adhering to the bottom sediments. The presence of tetrachloroethene, chlorobenzene, and 1,4-dichlorobenzene in the sediments indicates these contaminants have been present in the storm sewer system and were discharged into the stream where some portion has adhered to the sediments.

Oil and grease was detected in most sediment samples except the 8- to 12-inch interval at SG-16 and SG-17; however, the duplicate sample at SG-17 did have concentrations of oil and grease. The concentrations ranged from 30 mg/kg in the 4- to 8-inch interval at SG-1 to 6,000 mg/kg in the 8- to 12-inch interval at SG-9. At all locations except SG-1 and SG-9, the concentrations of oil and grease decreased with depth.

Table 4-4

Travis Air Force Base, Fairfield, California
Analytical Results, Union Creek Sediments, March 1985
(mg/kg)

Zone/Area	Staff Gauge No.	Oil and Grease	Tetrachloro-ethene	Chloro-benzene	1,4-Dichloro-benzene	Toluene	Ethyl-benzene
Storm Sewer Zone							
	SG-1, S1	30.	ND	ND	ND	ND	ND
	S2	65.	ND	ND	ND	ND	ND
	SG-301[a], S1	310.	ND	ND	ND	ND	ND
	S2	90.	ND	ND	ND	ND	ND
	SG-9, S1	3,300.	ND	ND	ND	0.075	2.000
	S2	6,000.	0.0015	0.008	0.0012	0.0160	3.400
	SG-16, S1	75.	ND	ND	ND	ND	ND
	S2	ND	ND	ND	ND	ND	ND
	SG-17, S1	400.	ND	ND	ND	ND	ND
	S2	ND	ND	ND	ND	ND	ND
	SG-317[a], S1	550.	ND	ND	ND	ND	ND
	S2	320.	ND	ND	ND	ND	ND
	SG-18, S1	300.	ND	ND	ND	ND	ND
	S2	260.	ND	ND	ND	ND	ND
Sewage Treatment Plant Zone							
	SG-10, S1	ND	ND	ND	ND	ND	ND
	S2	ND	ND	ND	ND	ND	ND
	SG-11, S1	230.	ND	ND	ND	ND	ND
	S2	180.	ND	ND	ND	ND	ND
	SG-12, S1	ND	ND	ND	ND	ND	ND
	S2	120.	ND	ND	ND	ND	ND
FTA-4	SG-13, S1	220.	ND	ND	ND	ND	ND
	S2	80.	ND	ND	ND	ND	ND
	SG-14, S1	2,200.	ND	ND	ND	ND	ND
	S2	230.	ND	ND	ND	ND	ND
	SG-15, S1	24,000.	ND	ND	ND	ND	ND
	S2	19,000.	ND	ND	ND	ND	ND
	Detection limit	20.	0.00005	0.0003	0.0002	0.0002	0.0002

[a]Duplicate sample.
S1 -- 4- to 8-inch interval.
S2 -- 8- to 12-inch interval.
ND -- Not detected.

Note: Only volatile organics detected are listed.

4.3.2.2 Sewage Treatment Plant Zone

Three locations (SG-10 to SG-12) were sampled in the Sewage Treatment Plant Zone. No volatiles were detected in any samples.

Oil and grease was detected in both intervals at SG-11 and in the 8- to 12-inch interval at SG-12. Concentrations ranged from 120 mg/kg at SG-12 to 230 mg/kg in the 4- to 8-inch interval at SG-11. The results are presented in Table 4-4.

4.3.2.3 Fire Training Area No. 4

Three locations (SG-13 to SG-15) were sampled along Union Creek in Fire Training Area No. 4. Table 4-4 presents the analytical results. No volatiles were detected in any of the samples.

Oil and grease was detected in most of the samples. The concentrations ranged from a high of 24,000 mg/kg in the 4- to 8-inch interval at SG-15, to a low of 80 mg/kg in the 8- to 12-inch interval at SG-13. The concentrations decreased with depth at all locations.

4.3.3 Significance of Soil and Sediment Results

Of the analytes sampled in soil and sediment at Travis AFB, the following volatile organics were detected in at least one sample: trichloroethene (TCE), tetrachloroethene (PCE), chlorobenzene, 1,4-dichlorobenzene, toluene, and ethylbenzene. The results are summarized in Tables 4-1 through 4-4.

The trichloroethene was detected in the Oil Spill Area and the Solvent Spill Area of the SSZ and in Fire Training Area No. 2 in the NLFZ. The TCE present in the Oil Spill Area is probably a result of past disposal of washwaters from Building 16 (engine repair) or solvents from Building 18 (cleaning and degreasing) to the surface drainage system. TCE detected in the Solvent Spill Area is probably a result of the past leaks and spills in that area as described in Subsection 1.3.1.2. At Fire Training Area No. 2 the TCE is most likely due to the past use of waste solvents to fuel fires for training exercises.

The other volatiles detected were found in the stream sediments at location SG-9. As discussed in Subsection 4.3.2.1, the presence of these volatiles in the sediments indicates that discharge of the compounds from the Storm Sewer System to the stream has occurred and may still be occurring. Some portions of the compounds are adhering to the stream sediments.

Oil and grease was detected in the Oil Spill Area and Solvent Soill Area of the SSZ and in sediments from Union Creek. The oil and grease analysis does not quantify a specific compound, but measures groups of substances on the basis of their common solubility in Freon. Therefore, the specific identity of the compounds contributing to a measurement of oil and grease is unknown. Most components and by-products of petroleum-based products, including aromatics such as toluene and benzene, as well as heavier molecules, are soluble in Freon, and are included in a total oil and grease analysis.

All soils analyzed for oil and grease at Travis AFB were also analyzed for volatile organics. For samples in which volatile organics were not detected the data indicate that if petroleum-derived compounds were part of the oil and grease measured, they are most likely heavier, less mobile, and in general, less toxic than the volatile aromatics. Where the volatile aromatics were detected (SG-9) the data indicate that the source may be petroleum based.

As in the case with oil and grease, the petroleum hydrocarbon analysis does not quantify a specific compound, but measures groups of substances on the basis of their common solubility in Freon. The oil and grease analysis includes mineral oils as well as animal greases and vegetable oils. Therefore, low levels (<70 mg/kg) may be attributable to natural vegetative decay processes. The petroleum hydrocarbon analysis includes only the mineral oils. All soils analyzed for petroleum hydrocarbons were also analyzed for volatile organics, and only TCE was detected. The data indicate that where petroleum-derived compounds were part of the petroleum hydrocarbons measured, they are most likely heavier, less mobile, and in general, less toxic than the volatile aromatics.

Based on this investigation, none of the sites where soils or stream sediments were sampled at Travis AFB are considered to warrant further soils investigation.

4.4 WATER QUALITY RESULTS FOR GROUNDWATER

This subsection reviews chemical data obtained from groundwater samples collected at Travis AFB in March and May 1985. Samples were collected in two rounds (8 to 22 March and 3 to 16 May 1985) from 34 newly-installed monitoring wells screened in the shallow water table aquifer. The methods used in sample collection are described in Section 3 and in the Field Sampling and QA/QC Plan (Appendix H). Laboratory methods used in sample analysis are listed in Appendix J, and laboratory reports are provided in Appendix K. Applicable Federal and State water quality standards are referenced in Appendix L.

All of the available water quality data from the groundwater investigation have been summarized in Tables 4-7 through 4-41. The data have been arranged by zone and/or area. Tables 4-7 through 4-10, 4-15 through 4-17, 4-25 through 4-27, and 4-34 through 4-36 summarize the results of the VOA and base/neutral analyses listing only those parameters that were detected at least once within the set of wells in that zone or area. Tables 4-18, 4-19, 4-28, and 4-29 summarize the pesticide and herbicide analytical results. Tables 4-11, 4-12, 4-20, 4-21, 4-30, 4-31, 4-37, and 4-38 summarize the potability factors analyses, and Tables 4-13, 4-14, 4-22, 4-23, 4-24, 4-32, 4-33, 4-39, 4-40, and 4-41 summarize the metals, TOC, phenols, oil and grease, and petroleum hydrocarbon results. The field test results (pH, temperature, and specific conductivity) are presented in Tables 3-4 through 3-7.

Due to the volume of data generated from the groundwater investigation at Travis AFB, the site-specific data review will be preceded by a discussion of the significance of the findings. This discussion will serve to establish the basis for the subsequent site-by-site evaluation of the groundwater quality data.

4.4.1 Significance of Groundwater Results

The significance of the groundwater results at a specific site will be determined primarily from a comparison of those results with natural or background levels for the same compounds, and with Federal or State of California water quality standards (when they exist) for those compounds. A general data review will serve to establish background levels for each analyte in the analytical protocol, as well as to highlight the degree of variability to be expected in groundwater results.

4.4.1.1 Data Review

This subsection provides a general discussion of the data in Tables 4-7 through 4-41 on a parameter basis.

The results for the 32 priority pollutant volatile organic compounds plus MEK are summarized in Tables 4-7, 4-8, 4-15, 4-16, 4-25, 4-26, 4-34, and 4-35. Only those compounds actually detected have been listed. Due to the volatility of these compounds, VOA's are often difficult to sample, especially at low levels, therefore, the samples were collected using a decontaminated Teflon bailer. California Assessment Method (CAM) procedures were followed when collecting the samples for analysis by EPA Method 624.

Some remarks can be made concerning specific volatile organic compounds based on the data in Appendix K. In the second sampling round, 1,1,1-trichloroethane was found at anomalously high levels ranging from 0.0067 mg/L to 0.014 mg/L in field blanks. However, in general, 1,1,1,-trichloroetnane showed fairly good reproducibility between field duplicates and between rounds, with an overall increase in concentrations in the second round. Therefore, these results are considered indications of 1,1,1-trichloroethane in the groundwater.

Chloroform was also detected in field blanks in the second sampling round at levels ranging from 0.006 mg/L to 0.014 mg/L. Like 1,1,1-trichloroethane, chloroform showed fairly good reproducibility between field duplicates and between rounds. No overall trend in concentrations is apparent. A number of volatiles were detected in only one sampling round in various zones and areas. These compounds are listed on Table 4-5. The following general rules have been applied in the evaluation of site-specific data: a compound has not been considered "confirmed" in an area unless it was reported in both rounds of sampling, and reported concentrations of volatiles below 0.001 mg/L have been considered to have relatively lower reliability than reported concentrations above 0.001 mg/L. Background levels of all volatile organic compounds in groundwater should be considered zero, since these are not naturally-occurring compounds.

In comparing the volatile concentrations to Federal and state standards, it should be noted that, due to the requirement by the State of California to use EPA Metnod 624 for volatile organics analysis, the detection limit for benzene and 1,1-dichloroethene is greater than the standard or action level.

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Table 4-5

Volatile Compounds Detected in Only One Sampling Round

Zone/Area	Compound
Storm Sewer Zone	MEK Bromoform Chlorodibromomethane 1,1-Dichloroethene
Landfill No. 3	Benzene Toluene 1,1,2,2-Tetrachloroethane Tetrachloroethane MEK
Fire Training Area No. 4 and Sewage Treatment Plant Zone	Chlorobenzene 1,1,2,2-Tetrachloroethane Tetrachloroethane 1,1-Dichloroethene Bromodichloromethane Toluene Bromoform Chlorodibromomethane
North Landfill Zone	Bromodichloromethane 1,2-Dichloroethane

The base/neutral compounds were analyzed by EPA Method 625. Di-n-butyl phthalate and diethyl phthalate were found in trace amounts in field blanks during the first round. These levels are not large enough to cause interference with sample analysis. The Storm Sewer Zone was the only area where base/neutrals were detected in both sampling rounds. Compounds detected only during one round of sampling in the SSZ include di-n-butyl phthalate, diethyl phthalate, hexachloroethane, bis(2-ethylhexyl)phthalate, naphthalene, the coelutes benzo(a)anthracene and chrysene, and the coelutes anthracene and phenanthrene. Similar to volatile organics, only those base/neutral compounds detected in both sampling rounds will be confirmed. No acid-extractable compounds were detected in either sampling round. Background levels of all base/neutral compounds in groundwater should be considered zero, since these are not naturally-occurring compounds.

Base/neutral and volatile compounds detected in trace amounts (detected below detection limits) have been referred to as an "identified" compound.

Oil and grease, petroleum hydrocarbons, and TOC analyses were performed on most groundwater samples. All three analyses are not compound-specific determinations, which analyze for groups of organic compounds rather than individual components. The detection limits for TOC (1.0 mg/L), oil and grease (0.1 mg/L), and petroleum hydrocarbons (0.1 mg/L) are in general too high for these parameters to be correlated to specific organic compounds, such as TCE, found in groundwater at Travis AFB. For the oil and grease analysis, nondetectable concentrations occur at 0.1 mg/L, therefore, 0.1 mg/L should be considered background. However, low levels (<1.0 mg/L) may be attributable to natural vegetative decay processes.

TOC was detected in every groundwater sample taken at Travis AFB above the detection limit of 1.0 mg/L. Between sampling rounds, there was very little reproducibility of results. In general, the TOC concentrations increased in the second round.

TOC is a general contaminant indicator for organic contamination. It is not uncommon for TOC in shallow water table aquifers to range above 10 mg/L. Due to experimental noise and the reliability of the TOC analysis, background concentrations have been considered to be 10 mg/L for TOC.

The petroleum hydrocarbon analysis performed in the first round was only able to achieve a detection limit of 0.2 mg/L. The analysis was performed strictly according to the EPA-recommended methodology. For the second round, in order to achieve the required detection limit of 0.1 mg/L, a smaller volume of sample was extracted for a longer period of time, resulting in a more concentrated sample. Therefore, second round results will be considered more representative than first round results.

Phenols were analyzed using EPA Method 420.1 and were non-detectable at 0.1 mg/L. Phenols were detected in three samples in the first round at 0.2 mg/L in the Storm Sewer Zone, however, phenols were not detected at these locations in the second round, and, therefore, were not confirmed. The program detection limit for phenol is greater than the State Action Level.

Pesticides and herbicides were detected in both sampling rounds. The pesticide endrin and the herbicide 2,4-D were most prevalent. These are not naturally-occurring compounds, therefore, natural concentrations should be considered zero.

Barium, zinc, and mercury were the only metals detected in both sampling rounds. Lead was detected in the first round, and nickel and selenium were detected in the second round, therefore, the existence of these metals in the groundwater is not confirmed.

Potability factors were analyzed for all samples. These parameters are utilized by the State of California to determine the suitability of groundwater for drinking and supply purposes. These parameters include alkalinity, chloride, nitrate (as N), sulfate, total dissolved solids, calcium, magnesium, and sodium.

Alkalinity represents the ability of a solution to neutralize acid. A variety of solute species contribute to the alkalinity of water. The majority of alkalinity is produced by dissolved bicarbonate and carbonate ions. The alkalinity contributes to the hardness of water. At Travis AFB, the alkalinity ranges from nondetected to 1,300 mg/L in the groundwater.

Chloride in the area of Travis AFB has been reported to be greater than 100 mg/L, as discussed in Section 2. Chloride is considered a conservative ion, that is, the concentration of chloride in groundwater is not significantly altered by oxidation or reduction reactions; the ions do not form important solute complexes with other ions or salts of low solubility. The chloride ions are also not significantly adsorbed onto mineral surfaces. Therefore, chloride is a good indicator of groundwater quality. Based on data contained in Evenson (1985), the background concentration range for chloride will be 100 to 250 mg/L.

Nitrate was analyzed by EPA Method 353.2, as specified in the Task Order. This method actually measures nitrate and nitrite combined, as nitrogen, because the sample is preserved with sulfuric acid. In general, nitrite is unstable and oxidizes to nitrate, except under highly reducing conditions, and nitrite in shallow groundwater (as in surface water) would be expected to represent a very small (5 percent) proportion of the total nitrate/nitrite concentrations measured. Therefore, in the following discussions, reported concentrations for this parameter are treated as if they were for nitrate alone. Nitrate results exhibited good reproducibility between duplicates and between rounds. Nitrate concentrations ranged between non-detected to 350 mg/L in groundwater at Travis AFB. Background nitrate levels have ranged from 1.2 mg/L to 18 mg/L near Travis (see Section 2).

Sulfate in the area near Travis AFB is found in concentrations ranging from 20 mg/L to 50 mg/L (Evenson, 1985). Sulfate is formed when the element sulfur is dissolved in water and complexed with oxygen. The sulfate ion is chemically stable in shallow groundwater. Sulfate is a concern in drinking water because high concentrations may have a cathartic effect on people accustomed to low sulfate concentrations, however, people are easily acclimatized to high sulfate concentrations. Twelve wells at Travis had sulfate concentrations exceeding the EPA secondary drinking water standard of 250 mg/L.

Total dissolved solids concentrations may affect drinking water detrimentally by producing objectionable odors, taste, and staining. The usability of water high in dissolved solids is determined by the constituents contributing to the dissolved solids concentration. Therefore, EPA has set a secondary drinking water standard at 500 mg/L. In the Travis AFB area, concentrations of dissolved solids are greater than 500 mg/L (Evenson, 1985). Almost all of the wells at Travis also had concentrations greater than 500 mg/L. Due to the high background dissolved solids concentrations in the area, the range of 500 to 1,000 mg/L will be considered as background.

Calcium, magnesium, and sodium concentrations are utilized in characterizing groundwater, as discussed in Section 2. These constituents are also utilized in calculating the sodium adsorption ratio (SAR) for irrigation waters. High sodium concentrations relative to calcium and magnesium decrease the permeability of soil making it difficult to supply crops with water via irrigation. Groundwater near Travis AFB is classified C_3S_1 (high salinity, low sodium hazard) for irrigation (Evenson, 1985).

Specific conductivity (in umhos/cm), pH (in standard units), and temperature (in °C) were measured in the field within 6 hours of sample collection. These results are listed in Tables 3-4 through 3-7. The specific conductivity in groundwater at Travis AFB, when corrected to 25°C, ranged from 500 to 8,489 umhos/cm. Values of pH ranged from 4.1 to 8.1 and were generally above 7.0.

4.4.1.2 Federal and State Water Quality Standards

A complete listing of applicable Federal and California drinking water and human health standards is provided in Appendix L. This subsection reviews the evolution and meaning of those standards.

EPA originally promulgated a set of interim primary drinking water standards based on human health criteria in 1975, to which was added a set of recommended secondary drinking water standards based on taste, odor, and aesthetic considerations. In 1980, EPA adopted the term "maximum contaminant level" (MCL) for all current drinking water standards.

On 28 November 1980, EPA issued criteria for 64 toxic pollutant categories that could be found in water. The criteria established recommended maximum concentrations for acute and chronic exposure to these pollutants for both human and aquatic life. The derivation of these exposure values was based on cancer risk, toxic properties, and organoleptic properties.

The limits set for cancer risk were not based on a "safe" level for carcinogens in water. The criteria stated that, for maximum protection of human health, the concentration should be zero. However, where this cannot be achieved, a range of concentrations corresponding to incremental cancer risks of from 1 in 10 million to 1 in 100,000 was presented (10^{-7} to 10^{-5}).

In addition to the cancer risk assessment criteria, the EPA Office of Drinking Water provides, on request, advice on health effects concerning unregulated contaminants found in drinking water supplies. This information suggests the level of a contaminant in drinking water at which adverse health effects would not be anticipated with a margin of safety; it is called SNARL (suggested no adverse response level). Normally, values are provided for 1-day, 10-day, and longer-term exposure periods where available data exist. A SNARL does not condone the presence of a contaminant in drinking water, but rather provides useful information to assist in the setting of control

priorities in cases where the contaminant has been found. SNARL's are not legally enforceable standards, they are not issued as official regulations, and they may or may not lead ultimately to the issuance of a national standard or maximum contamination level (MCL). The latter must take into account the occurrence and relative source contribution factors in addition to health effects. It is quite conceivable that the concentrations set for SNARL purposes might differ from an eventual MCL. The SNARL's may also change as additional information becomes available. The State of California recommends the use of SNARL's for comparison purposes when no standard or action level exists.

On 12 June 1984, EPA published a set of proposed rules under the Safe Drinking Water Act that would establish recommended maximum contaminant levels (RMCL's) for the following volatile synthetic organic chemicals (VOC's) in drinking water: trichloroethene, tetrachloroethene, carbon tetrachloride, 1,1,1-trichloroethane, vinyl chloride, 1,2-dichloroethane, benzene, 1,1-dichloroethene, and p-dichorobenzene.

RMCL's are nonenforceable health goals that are to be set at levels that would result in no known or anticipated adverse health effects with an adequate margin of safety. This proposal is the initial stage of rulemaking for the establishment of primary drinking water regulations for the 9 VOC's. Following this proposal, maximum contaminant levels (MCL's) and monitoring/reporting requirements will be proposed when the MCL's are promulgated. MCL's will be enforceable standards. They are to be set as close to the RMCL's as is feasible, and are based on health, treatment technologies, costs, and other factors. It is anticipated that RMCL's for most of the compounds listed would be set in the range of 0.005 to 0.05 mg/L. EPA anticipates proposing additional RMCL's for other VOC's in the near future.

The State of California has adopted current Federal MCL's for 20 chemicals and radionuclides. In addition, the California Department of Health Services (CDHS) has established drinking water action levels currently covering 43 chemicals. These action levels, like SNARL's, are based exclusively on health risks, but, unlike SNARL's, are not merely advisory. Instead, they are enforced as MCL's for drinking water supplies in the State of California. In March 1985, they were adopted as guidance criteria for cleanups at hazardous substance sites by the California Water Resources Control Board (CWRCB).

Table 4-6 lists the applicable Federal and State water quality standards for the analytes sampled at Travis AFB. The last column in Table 4-5 lists the wells and staff gauge locations at Travis AFB in which the referenced standard was exceeded at least once. The CDHS action level for benzene, 1,1,1-trichloroethane, toluene, tetrachloroethene, trichloroethene, 1,1-dichloroethane, and SNARL's for chlorobenzene, and trans-1,2-dichloroethene were exceeded in wells and at staff gauge locations in the Storm Sewer Zone, Fire Training Area No. 4, Landfill No. 1, the Sewage Treatment Plant Zone, and Fire Training Area No. 3. The Federal standard for pH was not met in the Storm Sewer Zone, the Sewage Treatment Plant Zone, Fire Training Area No. 4, and Landfill No. 3. The Federal standard for sulfate was exceeded in wells in the Storm Sewer Zone and North Landfill Zone. Nitrate, with a Federal standard of 10 mg/L, was exceeded in wells in the Storm Sewer Zone, Landfill No. 3, Fire Training Area No. 4, the Sewage Treatment Plant Zone, and the North Landfill Zone. The CDHS action level for chloride was exceeded in all wells except MW-114 and MW-115. However, chloride levels exceeding the 100 mg/L action level are common in the area near Travis AFB, with concentrations increasing toward the Suisun Marsh.

The CDHS action level for mercury was exceeded in one well in the Sewage Treatment Plant Zone, and for selenium in one well in the North Landfill Zone. Endrin was found above the Federal standard in one well at Landfill No. 3, and one well in the Sewage Treatment Plant Zone. The CDHS action level for phenol was exceeded in one well and at two staff gauge locations within the Storm Sewer Zone. None of the other applicable standards (for total trihalomethanes, SNARL for MEK, one base/neutral, three pesticides, two herbicides, and eight metals) were exceeded in groundwaters or surface waters sampled at Travis AFB.

Table 4-6

Comparison of Groundwater Results with Applicable Water Quality Standards

Analyte[a]	Water Quality Standard	Reference	Well or Staff Gauge Location Equaling or Exceeding Standard at Least Once
VOA's (mg/L)			
Benzene	0.0007	1	MW-107, SG-2[a], SG-4[a], SG-6, SG-7, SG-8, SG-9, SG-14, SG-15[a]
1,1,1-Trichloroethane	0.200	1	MW-103[a]
Toluene	0.100	1	SG-308[a]
Tetrachloroethene	0.004	1	MW-103[a], SG-4[a], SG-6[a], SG-7[a]
Trichloroethene	0.005	1	MW-102, MW-103, MW-108, MW-109, MW-110, MW-119[a] MW-120[a], MW-130[a], MW-131[a], MW-132, SG-2, SG-3, SG-4, SG-6, SG-7, SG-8, SG-9, SG-14, SG-15, SG-16, SG-17[a], SG-18[a]
1,2-Dichloroethane	0.001	1	MW-119[a], MW-120[a] MW-121, MW-123[a], MW-131[a], MW-132[a]

Table 4-6
(continued)

Analyte[a]	Water Quality Standard	Reference	Well or Staff Gauge Location Equaling or Exceeding Standard at Least Once
1,1-Dichloroethene	LOQ (0.0001-0.0004)	1	MW-107[a], MW-110[a] MW-112[a], SG-13[a], SG-16[a], SG-17[a], SG-18[a]
Chlorobenzene	0.0047	3	MW-102[a], SG-[illegible]a
Trans-1,2-dichloroethene	0.270	4	SG-3
pH (SU)	6.5-8.5	2	MW-101, MW-102, MW-104[a], MW-106[a] SG-16[a], SG-17[a], SG-18[a], SG-15[a], SG-11[a], SG-12[a], SG-14[a], MW-113[a], MW-114[a]
Sulfate (mg/L)	250.	2	MW-101, MW-102, MW-103, MW-104, MW-105, MW-106, MW-107, MW-108, MW-109, MW-110, MW-111, MW-112, MW-113, MW-114[a], MW-116, MW-117, MW-118, MW-119, MW-120, MW-121, MW-122, MW-123, MW-124, MW-125, MW-126, MW-127,

Table 4-6
(continued)

Analyte[a]	Water Quality Standard	Reference	Well or Staff Gauge Location Equaling or Exceeding Standard at Least Once
Sulfate (mg/L) (continued)			MW-128, MW-129, MW-130, MW-131, MW-132, MW-133, MW-134, SG-1[a], SG-2[a], SG-4, SG-6, SG-7, SG-8, SG-8A, SG-9, SG-13, SG-14, SG-15, SG-16, SG-17, SG-18
Nitrate, as N (mg/L)	10.0	2	MW-102, MW-108[a], MW-113, MW-114, MW-115, MW-117, MW-118, MW-120, MW-121, MW-122, MW-123, MW-124[a], MW-125, MW-128, MW-129, MW-130[a]
Chloride (mg/L)	100.0	1	MW-101, MW-102, MW-103, MW-104, MW-105, MW-106, MW-107, MW-108[a], MW-109, MW-110, MW-111, MW-112, MW-113, MW-116, MW-117, MW-118, MW-119, MW-120, MW-121, MW-122, MW-123, MW-124, MW-125, MW-126, MW-127, MW-128, MW-129, MW-130, MW-131, MW-132, MW-133[a], MW-134, SG-14, SG-15, SG-16

Table 4-6
(continued)

Analyte[a]	Water Quality Standard	Reference	Well or Staff Gauge Location Equaling or Exceeding Standard at Least Once
Mercury (mg/L)	0.002	1	MW-123[a]
Selenium (mg/L)	0.010	1	MW-127[a]
Endrin (mg/L)	0.0002	2	MW-114[a], MW-123[a]
Phenol (mg/L)	0.001	1	MW-107[a], SG-3[a], SG-3[a]

[a]Analyte detected in only one round -- not confirmed.

References for water quality standard:

1. California DHS action level.
2. Federal MCL (Primary or Secondary Drinking Water Standard).
3. EPA suggested no adverse response level (SNARL) chronic cancer.
4. EPA SNARL subchronic 10 days.

4.4.2 Site-Specific Groundwater Results

In this subsection groundwater results are evaluated on a zone-by-zone and site-specific basis, following the criteria defined in the previous subsection, including background levels and water quality standards.

4.4.2.1 Storm Sewer Zone

Four areas of investigation are located within the Storm Sewer Zone (Table 1-4). These were monitored by 12 newly-installed monitoring wells (MW-101 through MW-112). Groundwater data for the Storm Sewer Zone are summarized in Tables 4-7 through 4-14.

4.4.2.1.1 Fire Training Area No. 1

Monitoring well MW-101 was installed to sample groundwater in the vicinity of FTA-1. No volatile organics, base/neutral, or acid extractable compounds were detected and confirmed in both sampling rounds. 1,1,1-trichloroethane and fluoranthene were both detected in the March 1985 sampling round.

Potability factors were generally within background ranges, with the exception of sulfate, which exceeded the Federal Secondary Drinking Water Standard. No phenols were detected in either sampling round TOC and petroleum hydrocarbon concentrations were fairly high (TOC = 25 to 59 mg/L; petroleum hydrocarbons = 1.3 to 4.1 mg/L) indicating that waste fuels and oils used to fuel fires for training exercises have impacted the groundwater.

Overall, the data indicate that Fire Training Area No. 1 is a source of organic carbon, in the form of petroleum hydrocarbons, to the groundwater.

4.4.2.1.2 Oil Spill Area

MW-102 and MW-103 were installed to sample groundwater downgradient of the Oil Spill Area. Numerous volatile compounds were identified and confirmed in both sampling rounds. These included benzene, chloroform, toluene, chlordbenzene, 1,1,2,2-tetrachloroethane, trans-1,2-dichloroethene, PCE, and TCE. Of the compounds identified, well MW-103 contained the majority and had very high concentrations of TCE (3.5 to 4.5 mg/L). Base/neutral compounds were only detected in the first round of sampling, including di-n-butyl phthalate and diethyl phthalate. No acid extractables were detected in either round.

Table 4-7

Volatile Organic Compounds (mg/L)

Travis Air Force Base
Fairfield, California
Analytical Results -- March 1985

Area/Zone	Staff Gauge or Monitor Well	Benzene	1,1,1-Trichloroethane	Chloroform	Toluene	Methylethyl-ketone	Chlorobenzene	1,1,2,2-Tetrachloroethane	Trans-1,2-dichloroethene	Tetrachloroethene	Trichloroethene	1,1-Dichloroethane	Methylene chloride	1,2-Dichloroethane	Ethylbenzene	1,1-Dichloroethene
Storm Sewer Zone																
FTA-1	MW-101	ND	0.016	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	MW-201[a]	ND	0.0043	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Oil Spill Area	MW-102	Tr	0.017	0.0008	ND	ND	0.001	ND	0.220	ND	0.970	ND	ND	ND	ND	ND
	MW-103	Tr	0.220	ND	0.0012	ND	0.0006	0.0035	ND	0.0045	3.500	ND	ND	ND	ND	ND
Solvent Spill Area	MW-104	ND	0.014	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	MW-105	ND	0.019	0.001	ND	0.014	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	MW-106	ND	0.017	ND	Tr	ND	ND	Tr	ND	0.0005	ND	ND	ND	ND	ND	ND
Sewer Right-of-Way	MW-107	0.015	0.013	Tr	ND	ND	ND	ND	ND	ND	ND	ND	ND	Tr	0.0014	0.0007
	MW-108	ND	0.011	Tr	ND	ND	ND	Tr	0.017	Tr	0.043	0.0008	ND	ND	ND	ND
	MW-109	ND	0.006	0.0019	ND	ND	0.0008	ND	0.0027	ND	0.013	ND	ND	ND	ND	Tr
	MW-110	ND	0.025	Tr	0.0056	ND	ND	ND	0.0038	ND	0.015	ND	ND	ND	ND	0.0012
	MW-111	ND	0.015	0.0008	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	Tr
	MW-112	ND	0.020	Tr	ND	ND	ND	ND	ND	ND	ND	ND	ND	Tr	ND	0.001
	SG-1	ND	0.014	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	SG-2	ND	0.0095	0.015	ND	ND	ND	ND	0.016	ND	0.023	ND	0.0055	ND	ND	ND
	SG-3	ND	0.012	0.011	0.0073	ND	0.0091	ND	1.600	ND	0.057	ND	ND	ND	ND	ND
	SG-4	Tr	ND	Tr	0.0047	ND	ND	0.0031	0.027	0.003	0.120	ND	ND	ND	ND	ND
	SG-5	ND	ND	ND	0.0055	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	SG-6	0.026	ND	Tr	0.036	ND	ND	0.0047	0.078	0.004	3.100	ND	ND	ND	ND	ND
	SG-7	0.068	ND	ND	0.048	ND	0.0005	0.0036	0.060	0.0041	1.000	ND	ND	ND	0.044	ND
	SG-8A	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	SG-8	0.070	0.006	ND	0.081	ND	0.0009	0.0011	0.020	0.0015	0.120	ND	ND	ND	0.063	ND
	SG-308[a]	0.130	0.020	ND	0.072	ND	0.0006	0.0025	0.024	0.003	ND	ND	ND	ND	0.055	ND
	SG-9	0.110	ND	ND	0.042	ND	ND	0.0009	0.05	0.0012	0.770	ND	ND	ND	0.026	ND
	SG-16	0.001	0.017	0.0082	ND	ND	ND	ND	0.0031	ND	0.031	ND	0.0007	ND	ND	0.0007
	SG-17	ND	0.014	0.0009	ND	ND	ND	ND	Tr	ND	0.005	ND	ND	ND	ND	0.0006
	SG-18	Tr	0.0048	0.005	0.0093	ND	ND	ND	Tr	ND	0.005	ND	ND	ND	ND	0.0024
	SG-318	NR	NR	NR	NR	ND	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
	FB-4	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	Detection limit	0.001	0.0005	0.0005	0.001	0.001	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.001	0.0005

[a]Duplicate sample.
ND - Not detected.
Tr - Trace -- detected below detection limit.
NR - Not requested.

5913A

Table 4-8

Volatile Organic Compounds (mg/l)

Travis Air Force Base
Fairfield, California
Analytical Results -- May 1985

Area/Zone	Staff Gauge or Monitor Well	Benzene	1,1,1-Tri-chloro-ethane	Chloroform	Toluene	Chlorobenzene	1,1,2,2-Tetra-chloroethane	Trans-1,2-dichloro-ethene	Tetra-chloro-ethene	Trichloro-ethene	1,2-Dichloro-ethane	Bromodichloro-methane	1,1-Dichloro-ethane	[illegible]	Methylene	Chloroform-methane
Storm Sewer Zone																
FTA-1	MW-101	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	MW-201[a]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Oil Spill Area	MW-102	Tr	ND	0.0005	Tr	0.0087	ND	0.180	ND	0.503	ND	ND	ND	ND	ND	ND
	MW-103	Tr	ND	Tr	Tr	Tr	0.0023	0.170	0.0025	4.5	ND	ND	ND	ND	ND	ND
Solvent Spill Area	MW-104	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	MW-105	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	MW-106	ND	0.013	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Sewer Right-of-Way	MW-107	0.012	0.0055	ND	Tr	Tr	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	MW-108	ND	ND	Tr	ND	ND	0.0005	0.017	0.0005	0.054	0.0007	ND	Tr	0.0011	ND	ND
	MW-109	ND	ND	Tr	ND	ND	ND	0.0044	ND	0.019	Tr	ND	ND	ND	ND	ND
	MW-110	ND	ND	ND	ND	ND	ND	0.0039	ND	0.023	ND	ND	ND	ND	ND	ND
	MW-111	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	MW-112	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	SG-1	ND	ND	Tr	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	SG-2	0.0077	ND	0.0005	0.0052	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	SG-3	ND	0.013	0.011	0.0068	0.0013	ND	0.030	ND	0.0099	ND	ND	ND	ND	ND	ND
	SG-4	0.025	0.018	Tr	0.014	Tr	0.0052	0.460	ND	0.0041	ND	Tr	ND	0.007	ND	ND
	SG-5[b]	---	---	---	---	---	---	0.025	0.0067	0.600	ND	ND	ND	Tr	ND	ND
	SG-6	0.016	ND	Tr	0.0044	ND	D.0014	---	---	---	---	---	---	0.014	ND	ND
	SG-7	D.0073	ND	Tr	0.0027	ND	0.0016	0.360	0.0017	0.450	ND	ND	ND	---	---	---
	SG-8A	ND	0.011	ND	ND	ND	ND	0.170	0.0021	0.480	ND	ND	ND	0.011	ND	ND
	SG-8	0.210	0.015	ND	0.066	ND	Tr	ND	ND	ND	ND	ND	ND	0.0011	ND	ND
	SG-308[a]	0.400	ND	ND	0.120	ND	Tr	0.230	Tr	0.076	ND	ND	ND	0.0029	ND	ND
	SG-9	0.053	0.0086	Tr	0.0057	ND	ND	0.140	ND	0.049	ND	ND	ND	C.053	ND	ND
	SG-16	Tr	0.009	0.009	Tr	ND	Tr	0.074	0.0006	0.190	ND	ND	ND	0.110	ND	ND
	SG-17	ND	0.0006	0.0018	Tr	ND	ND	0.002	ND	0.006	ND	0.0018	ND	ND	ND	ND
	SG-18	ND	ND	0.0015	ND	ND	ND	ND	ND	0.0011	ND	Tr	ND	ND	Tr	Tr
	Detection limit	0.001	0.0005	0.0005	0.001	0.0005	0.0005	0.0005	0.0005	0.0009	ND	ND	ND	ND	ND	ND
										0.0005	0.0005	0.0005	0.001	0.001	0.0005

[a]Duplicate sample.
[b]Dry on day of sampling.
ND - Not detected.
Tr - Trace -- detected below detection limit.

5913A

Base/Neutral Compounds (mg/L)

Travis Air Force Base
Fairfield, California
Analytical Results -- March 1985

Area/Zone	Staff Gauge or Monitor Well	Fluoranthene	Di-n-butyl phthalate	Diethyl Phthalate	Hexachloro-ethane	1,2-Dichloro-benzene	1,3-Dichloro-benzene	1,4-Dichloro-benzene	Pyrene
Storm Sewer Zone									
FTA-1	MW-101	0.002	ND	ND	ND	ND	ND	ND	0.002
	MW-201[a]	ND	ND	ND	ND	ND	ND	ND	ND
Oil Spill Area	MW-102	ND	0.003	Tr	ND	ND	ND	ND	ND
	MW-103	ND	Tr	ND	ND	ND	ND	ND	ND
Solvent Spill Area	MW-104	ND	ND	ND	ND	ND	ND	ND	ND
	MW-105	ND	ND	ND	ND	ND	ND	ND	ND
	MW-106	ND	Tr	Tr	ND	ND	ND	ND	ND
Sewer Right-of-Way	MW-107	ND	ND	ND	ND	ND	ND	ND	ND
	MW-108	ND	ND	ND	ND	ND	ND	ND	ND
	MW-109	ND	ND	ND	ND	ND	ND	ND	ND
	MW-110	ND	ND	ND	ND	ND	ND	ND	ND
	MW-111	ND	0.006	ND	ND	ND	ND	ND	ND
	MW-112	ND	0.002	ND	ND	ND	ND	ND	ND
	SG-1	ND	ND	ND	ND	ND	ND	ND	ND
	SG-2	ND	ND	ND	ND	ND	ND	ND	ND
	SG-3	ND	ND	ND	0.010	0.008	0.0015	0.0047	ND
	SG-4	ND	0.003	ND	ND	ND	ND	ND	ND
	SG-5	ND	0.003	ND	ND	ND	ND	ND	ND
	SG-6	ND	ND	ND	ND	ND	ND	ND	ND
	SG-7	ND	Tr	ND	ND	ND	ND	ND	ND
	SG-8A	ND	ND	ND	ND	ND	ND	ND	ND
	SG-8	ND	0.002	ND	ND	ND	ND	ND	ND
	SG-308[a]	ND	0.002	ND	ND	ND	ND	ND	ND
	SG-9	ND	ND	ND	ND	ND	ND	ND	ND
	SG-16	ND	ND	ND	ND	ND	ND	ND	ND
	SG-17	ND	ND	ND	ND	ND	ND	ND	ND
	SG-18	ND	ND	ND	ND	ND	ND	ND	ND
	FB-4[b]	ND	ND	ND	ND	ND	ND	ND	ND
	Detection limit	0.002	0.002	0.002	0.001	0.001	0.001	0.001	0.001

[a]Duplicate sample.
[b]Field blank (taken same day as MW-107 through MW-112).
ND - Not detected.
Tr - Trace -- detected below detection limit.

Table 4-10

Base/Neutral Compounds (mg/L)

Travis Air Force Base
Fairfield, California
Analytical Results -- May 1985

Area/Zone	Staff Gauge or Monitor Well	Fluoranthene	1,2-Dichlorobenzene	1,3-Dichlorobenzene	1,4-Dichlorobenzene	Pyrene	Bis (2-ethylhexyl) phthalate	Naphthalene	Benzo(a) anthracene and Chrysene[a]	Anthracene and Phenanthrene[b]
Storm Sewer Zone										
FTA-1	MW-101	ND	ND	ND	ND	ND	ND	ND	ND	ND
	MW-201[c]	ND	ND	ND	ND	ND	ND	ND	ND	ND
Oil Spill Area	MW-102	ND	ND	ND	ND	ND	ND	ND	ND	ND
	MW-103	ND	ND	ND	ND	ND	ND	ND	ND	ND
Solvent Spill Area	MW-104	ND	ND	ND	ND	ND	0.260	ND	ND	ND
	MW-105	Tr	ND	ND	ND	Tr	ND	ND	ND	0.001
	MW-106	0.0029	ND	ND	ND	0.0027	ND	ND	Tr	ND
Sewer Right-of-Way	MW-107	ND	ND	ND	ND	ND	ND	ND	ND	ND
	MW-108	ND	ND	ND	ND	ND	ND	ND	ND	ND
	MW-109	ND	ND	ND	ND	ND	ND	ND	ND	ND
	MW-110	ND	ND	ND	ND	ND	ND	ND	ND	ND
	MW-111	ND	ND	ND	ND	ND	ND	ND	ND	ND
	MW-112	ND	ND	ND	ND	ND	ND	ND	ND	ND
	SG-1	ND	ND	ND	ND	ND	ND	ND	ND	ND
	SG-2	ND	ND	ND	ND	ND	ND	Tr	ND	0.660
	SG-3	ND	0.0012	Tr	0.0011	ND	ND	ND	ND	ND
	SG-4	ND	0.003	0.006	0.001	ND	ND	ND	ND	ND
	SG-5[d]	---	---	---	---	---	---	---	---	---
	SG-6	ND	ND	Tr	Tr	ND	ND	ND	ND	ND
	SG-7	ND	ND	ND	ND	ND	ND	ND	ND	ND
	SG-8A	ND	ND	ND	ND	ND	ND	ND	ND	ND
	SG-8	ND	ND	ND	ND	ND	ND	ND	ND	ND
	SG-308[c]	ND	ND	ND	ND	ND	ND	ND	ND	ND
	SG-9	ND	ND	ND	ND	ND	ND	ND	ND	ND
	SG-16	ND	ND	ND	ND	ND	ND	ND	ND	ND
	SG-17	ND	ND	ND	ND	ND	ND	ND	ND	ND
	SG-18	ND	ND	ND	ND	ND	ND	ND	ND	ND
	Detection limit	0.002	0.001	0.001	0.001	0.001	0.002	0.001	0.005	0.001

[a]Benzo(a)anthracene and chrysene coelute. Quantity is the sum of the two compounds.
[b]Anthracene and phenanthrene coelute. Quantity is the sum of the two compounds.
[c]Duplicate sample.
[d]Dry on date of sampling.
ND - Not detected.
Tr - Trace -- detected below detection limit.

Table 4-11

Inorganic Compounds (mg/l)

Travis Air Force Base
Fairfield, California
Analytical Results -- March 1985

Area/Zone	Staff Gauge or Monitor Well	Alkalinity	Chloride	Nitrate	Sulfate	Total Dissolved Solids	Calcium	Magnesium	Sodium
Storm Sewer Zone									
FTA-1	MW-101	ND	170.	0.1	330.	860.	19.	26.	160.
	MW-201[a]	ND	170.	0.1	330.	860.	22.	26.	160.
Oil Spill Area	MW-102	230.	220.	20.	410.	1,300.	120.	52.	210.
	MW-103	310.	310.	0.7	490.	1,500.	150.	50.	260.
Solvent Spill Area	MW-104	380.	600.	0.4	2,500.	5,300.	300.	160.	580.
	MW-105	480.	420.	6.3	2,600.	5,200.	570.	170.	500.
	MW-106	430.	120.	0.2	2,600.	4,500.	440.	150.	400.
Sewer Right-of-Way	MW-107	270.	350.	2.5	60.	890.	30.	14.	290.
	MW-108	370.	80.	9.0	80.	660.	56.	16.	190.
	MW-109	290.	160.	1.4	45.	610.	107.	32.	110.
	MW-110	390.	160.	4.2	75.	750.	30.	13.	230.
	MW-111	260.	1,000.	7.7	80.	2,200.	53.	28.	580.
	MW-112	250.	940.	9.1	85.	2,000.	30.	20.	550.
	SG-1	230.	250.	0.8	65.	690.	50.	20.	180.
	SG-2	190.	60.	11.	80.	430.	41.	25.	71.
	SG-3	240.	60.	6.7	70.	410.	61.	28.	60.
	SG-4	290.	110.	3.6	75.	520.	50.	19.	140.
	SG-5	130.	20.	7.7	15.	100.	27.	3.9	19.
	SG-6	350.	120.	5.3	95.	650.	41.	17.	190.
	SG-7	370.	130.	4.1	95.	650.	41.	16.	190.
	SG-8	390.	200.	4.4	85.	860.	53.	20.	250.
	SG-308[a]	410.	190.	2.7	120.	880.	56.	21.	260.
	SG-8A	260.	100.	0.6	20.	410.	56.	14.	100.
	SG-9	410.	170.	3.5	100.	810.	51.	19.	230.
	SG-16	220.	270.	6.6	100.	770.	53.	28.	200.
	SG-17	310.	300.	4.0	230.	1,200.	93.	43.	220.
	SG-18	200.	350.	1.4	180.	1,000.	70.	36.	250.
	FB-4[b]	5.	ND	0.1	ND	22.	ND	ND	ND
	Detection limit	1.	0.5	0.1	10.	10.	0.05	0.005	0.01

[a]Duplicate sample.
[b]Field blank (taken same day as MW-107 through MW-112).
ND - Not detected.

5913A

Table 4-12

Inorganic Compounds (mg/L)

Travis Air Force Base
Fairfield, California
Analytical Results -- May 1985

Area/Zone	Staff Gauge or Monitor Well	Alkalinity	Chloride	Nitrate	Sulfate	Total Dissolved Solids	Calcium	Magnesium	Sodium
Storm Sewer Zone									
FTA-1	MW-101	ND	160.	0.1	320.	1,100.	2.9	24.	150.
	MW-201[a]	ND	160.	0.5	300.	1,000.	2.7	23.	160.
Oil Spill Area	MW-102	200.	220.	15.	540.	1,500.	120.	60	200.
	MW-103	310.	320.	8.6	520.	1,600.	160.	60.	260.
Solvent Spill Area	MW-104	400.	590.	ND	2,600.	5,300.	510.	200.	1,200.
	MW-105	550.	400.	5.8	2,700.	5,600.	450.	200.	1,000.
	MW-106	380.	100.	0.1	2,500.	4,500.	400.	180.	950.
Sewer Right-of-Way	MW-107	520.	350.	2.2	41.	990.	33.	23.	280.
	MW-108	350.	120.	12.	100.	750.	43.	16.	190.
	MW-109	440.	180.	2.1	51.	870.	72.	33.	200.
	MW-110	330.	170.	1.6	67.	1,400.	34.	18.	240.
	MW-111	240.	560.	9.5	80.	2,200.	43.	33.	700.
	MW-112	240.	580.	8.9	84.	2,200.	36.	23.	750.
	SG-1	230.	100.	2.2	52.	450.	36.	19.	75.
	SG-2	650.	130.	0.1	57.	940.	170.	70.	270.
	SG-3	190.	160.	3.4	70.	420.	46.	29.	56.
	SG-4	400.	110.	5.4	100.	750.	46.	24.	210.
	SG-5[b]	---	---	---	---	---	---	---	---
	SG-6	430.	140.	4.1	110.	850.	36.	16.	240.
	SG-7	410.	140.	4.6	110.	820.	34.	14.	240.
	SG-8	470.	130.	1.4	100.	760.	58.	25.	280.
	SG-308[a]	510.	300.	2.6	59.	1,200.	61.	23.	290.
	SG-8A	400.	450.	0.5	ND	1,400.	90.	23.	320.
	SG-9	470.	200.	1.7	97.	1,100.	47.	18.	260.
	SG-16	230.	230.	3.1	10.	710.	46.	27.	150.
	SG-17	230.	230.	1.4	20.	730.	64.	32.	150.
	SG-18	230.	220.	0.8	140.	910.	62.	33.	160.
	Detection limit	1.	0.5	0.1	10.	10.	0.05	0.005	0.01

[a]Duplicate sample.
[b]Dry on day of sampling.
ND - Not detected.

5913A

Table 4-13

Travis Air Force Base
Fairfield, California
Analytical Results -- March 1985

Area/Zone	Staff Gauge or Monitor Well	TOC (mg/L)	Phenols (mg/L)	Oil and Grease (mg/L)	Petroleum Hydrocarbons (mg/L)
Storm Sewer Zone					
FTA-1	MW-101	59.	ND	NR	4.1
	MW-201[a]	35.	ND	NR	NR
Oil Spill Area	MW-102	5.	ND	0.5	NR
	MW-103	17.	ND	3.8	NR
Solvent Spill Area	MW-104	4.	ND	0.4	NR
	MW-105	12.	ND	1.2	NR
	MW-106	2.	ND	0.5	NR
Sewer Right-of-Way	MW-107	2.	0.2	NR	NR
	MW-108	2.	ND	NR	NR
	MW-109	4.	ND	NR	NR
	MW-110	1.	ND	NR	NR
	MW-111	7.	ND	NR	NR
	MW-112	3.	ND	NR	NR
	SG-1	8.	ND	NR	NR
	SG-2	8.	ND	NR	NR
	SG-3	4.	0.2	NR	NR
	SG-4	3.	ND	NR	NR
	SG-5	8.	ND	NR	NR
	SG-6	3.	ND	NR	NR
	SG-7	3.	ND	NR	NR
	SG-8A	8.	ND	NR	NR
	SG-8	5.	ND	NR	NR
	SG-308[a]	5.	---[b]	NR	NR
	SG-9	3.	0.2	NR	NR
	SG-16	4.	ND	NR	NR
	SG-17	11.	ND	NR	NR
	SG-18	5.	ND	NR	NR
	FB-4[c]	ND	ND	1.2	NR
	Detection limit	1.	0.1	0.1	0.2

[a]Duplicate sample.
[b]Sample broken in transit to subcontractor laboratory.
[c]Field blank (taken same date as MW-107 through MW-112).
ND - Not detected.
NR - Not requested.

Table 4-14

Travis Air Force Base
Fairfield, California
Analytical Results -- May 1985

Area/Zone	Staff Gauge or Monitor Well	TOC (mg/L)	Phenols (mg/L)	Oil and Grease (mg/L)	Petroleum Hydrocarbons (mg/L)
Storm Sewer Zone					
FTA-1	MW-101	25.	ND	NR	1.3
	MW-201[a]	44.	ND	NR	NR
Oil Spill Area	MW-102	8.	ND	ND	NR
	MW-103	10.	ND	ND	NR
Solvent Spill Area	MW-104	19.	ND	1.2	NR
	MW-105	22.	ND	1.2	NR
	MW-106	7.	ND	0.93	NR
Sewer Right-of-Way	MW-107	12.	ND	NR	NR
	MW-108	3.	ND	NR	NR
	MW-109	7.	ND	NR	NR
	MW-110	13.	ND	NR	NR
	MW-111	9.	ND	NR	NR
	MW-112	11.	ND	NR	NR
	SG-1	3.	ND	NR	NR
	SG-2	4.	ND	NR	NR
	SG-3	15.	ND	NR	NR
	SG-4	58.	ND	NR	NR
	SG-5[b]	---	---	---	---
	SG-6	7.	ND	NR	NR
	SG-7	10.	ND	NR	NR
	SG-8A	35.	ND	NR	NR
	SG-8	17.	ND	NR	NR
	SG-308[a]	4.	ND	NR	NR
	SG-9	2.	ND	NR	NR
	SG-16	4.	ND	NR	NR
	SG-17	33.	ND	NR	NR
	SG-18	6.	ND	NR	NR
	Detection limit	1.0	0.1	0.1	0.1

[a]Duplicate sample.
[b]Dry on date of sampling.
ND - Not detected.
NR - Not requested.

5913A

Potability factors were generally within background ranges, with the exception of TDS and nitrate. The high nitrates in MW-102 may be emanating from a domestic sewer line that runs near the well if the line is leaking.

TOC values range from 5 to 17 mg/L. No phenols were detected in either sampling round. Oil and grease was detected in the March 1985 sampling only. This could be because the water levels are higher than the tops of the screens (Figure 3-4). If the oil and grease were in the form of floating hydrocarbons, they could have been drawn into the wells during development, but would be unable to come back into the well for the second round of sampling.

The results of this investigation indicate that MW-103 is generally more contaminated than MW-102. Many of the constituents detected in both wells are solvents used in cleaning and degreasing. The most likely source of these solvents is Building 18, the Cleaning and Degreasing Shop. In the past, waste solvents and other cleaning agents were disposed of through the surface drainage system allowing seepage into the groundwater to occur. In addition, while conducting IRP Phase II investigations, WESTON field personnel noticed soapy runoff emanating from Building 18 and ponding near MW-103. This practice could presently be allowing contaminant entry into the groundwater.

4.4.2.1.3 Solvent Spill Area

Three monitoring wells were installed to monitor the Solvent Spill Area. These wells include MW-104 upgradient and MW-105 and MW-106 downgradient of the spill site. Only 1,1,1-trichloroethane was detected and confirmed in MW-106 in both sampling rounds. Other volatiles identified included chloroform, toluene, MEK, PCE, and 1,1,2,2-tetrachloroethane. These constituents probably emanate from the solvent spill detected in June 1981 and perhaps other unidentified spills. No base/neutral or acid extractable compounds were confirmed, however, di-n-butyl phthalate, diethyl phthalate, fluoranthene, pyrene, bis(2-ethylhexyl)phthalate, and the coelutes benzo(a)anthracene and chrysene, and the coelutes anthracene and phenanthrene were identified in one sampling round each.

Potability factors are somewhat elevated in this area, particularly chlorides, sulfates, TDS, calcium, magnesium, and sodium. TOC concentrations ranged from 2 to 22 mg/L. Oil and grease was detected in each well at levels ranging from 0.4 to 1.2 mg/L. No phenols were detected.

This investigation confirmed the presence of volatile organics in the groundwater due to the solvent spill discovered in June 1981. The data also indicated that other contaminants are present and, therefore, other spills may have occurred, or an upgradient source exists.

4.4.2.1.4 Sewer Right-of-Way

Six wells (MW-107 through MW-112) were installed to sample the groundwater along the contaminated Sewer Right-of-Way and to determine the relationship between contamination in the storm sewer system and the groundwater. Numerous volatile organic compounds were identified and confirmed, including benzene, 1,1,1-trichloroethane, chloroform, toluene, chlorobenzene, 1,1,2,2-tetrachloroethane, trans-1,2-dichloroethene, PCE, TCE, 1,2-dichloroethane, 1,1-dichloroethane, and ethylbenzene. Many of these constituents were also detected in the storm drains near the wells, however, the storm drains generally had higher concentrations. These data appear to indicate that the storm sewer system is the source of contamination to the groundwater. This will be discussed further in Subsection 4.5. The only base/neutral compound detected was di-n-butyl phthalate in March 1985. No acid extractables were detected in either sampling round.

Potability factors are within background ranges, except for chlorides, TDS, and sodium in wells MW-111 and MW-112. TOC concentrations ranged from 1 to 13 mg/L, and phenols were detected in MW-107 in March 1985.

Based on the results of this investigation, groundwater along the Sewer Right-of-Way is contaminated with volatile organic compounds. The source appears to be the storm sewer system. This will be discussed in more detail in Subsection 4.5.

4.4.2.2 Landfill No. 3

Analytical results for the monitoring wells (MW-113 through MW-115) around Landfill No. 3 are listed in Tables 4-15 through 4-24. The only compounds detected and confirmed in the wells were 1,1,1-trichloroethane in MW-114 and MW-115, and chloroform in MW-114. However, both of these volatile organics were detected in a field blank (at lower concentrations) in the first round. Other VOC's identified in one sampling round were benzene, 1,1,2,2- tetrachloroethane, toluene, PCE, and MEK. The only volatile organic that is associated with pesticides and herbicides is 1,1,2,2-tetrachloroethane, which is used in soil sterilization, weed killers, and insecticide formulations. The monitoring wells are upgradient of the rest of the Base, therefore, the presence of the other VOC's indicates that wastes other than pesticide and herbicide wastes may have been disposed of in the landfill, or an off-site source may be impacting the groundwater north of the Base. No base/neutral or acid extractable compounds were confirmed for both sampling rounds. Diethyl phthalate and di-n-butyl phthalate were identified in the first round of sampling. These compounds are associated with plastics and plastic wastes.

Of the six pesticides and herbicides analyzed only endrin in MW-114 was detected and confirmed in both sampling rounds. In the May 1985 sampling round, the endrin concentration (0.00036 mg/L) exceeded the Federal Primary Drinking Water Standard of 0.0002 mg/L. The following pesticides and herbicides were detected in one sampling round: methoxychlor, lindane, 2,4-D, and 2,4,5-TP. The presence of these compounds indicates possibly more extensive contamination, however, the levels were all below Federal standards.

Barium was detected and confirmed in MW-113, MW-114, and the duplicate sample of MW-115 in both sampling rounds. The concentration of barium in natural water tends to be controlled by the solubility of barium sulfate or barite, a fairly common mineral (Hem, 1978). Barium could also be a constitutent of the pesticide and herbicide wastes disposed of in Landfill No. 3. Nickel was detected in all of the wells around Landfill No. 3 in the second sampling round.

Table 4-15

Volatile Organic Compounds (mg/L)

Travis Air Force Base
Fairfield, California
Analytical Results -- March 1985

Area/Zone	Staff Gauge or Monitor Well	Benzene	1,1,1-Trichloroethane	Chloroform	Toluene	Methylethylketone
Landfill No. 3	MW-113	Tr	ND	0.0009	Tr	0.0048
	MW-114	Tr	0.018	0.0048	Tr	ND
	MW-115	Tr	0.017	ND	Tr	ND
	FB-1[a]	Tr	0.014	0.0009	Tr	ND
JP-4 Spill Area	MW-116	ND	0.0082	ND	ND	ND
	MW-216[b]	ND	0.012	ND	ND	ND
	Detection limit	0.001	0.0005	0.0005	0.001	0.001

[a]Field blank (taken same date as MW-113 through MW-115).
[b]Duplicate sample.
ND - Not detected.
Tr - Trace -- Detected below detection limit.

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Table 4-16

Volatile Organic Compounds (mg/L)

Travis Air Force Base
Fairfield, California
Analytical Results -- May 1985

Area/Zone	Staff Gauge or Monitor Well	1,1,1-Trichloroethane	1,1,2,2-Tetrachloroethane	Chloroform	Tetrachloroethene
Landfill No. 3	MW-113	ND	Tr	ND	Tr
	MW-114	0.0097	ND	0.003	ND
	MW-115	0.0066	ND	Tr	ND
JP-4 Spill Area	MW-116	0.011	ND	Tr	ND
	MW-216[a]	0.0006	ND	Tr	ND
	Detection limit	0.0005	0.0005	0.0005	0.0005

[a]Duplicate sample.
ND - Not detected.
Tr - Trace -- Detected below detection limit.

Table 4-17

Base/Neutral Compounds (mg/L)

Travis Air Force Base
Fairfield, California
Analytical Results -- March 1985

Area/Zone	Staff Gauge or Monitor Well	Di-n-butyl Phthalate	Diethyl Phthalate
Landfill No. 3	MW-113	0.002	Tr
	MW-114	0.002	Tr
	MW-115	ND	ND
	FB-1[a]	Tr	ND
JP-4 Spill Area	MW-116	ND	ND
	MW-216[b]	ND	ND
	Detection limit	0.002	0.002

[a]Field blank (taken same date as MW-113 through MW-115).
[b]Duplicate sample.
ND - Not detected.
Tr - Trace -- Detected below detection limit.

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Table 4-18

Herbicides/Pesticides (mg/L)

Travis Air Force Base
Fairfield, California
Analytical Results -- March 1985

Area/Zone	Staff Gauge or Monitor Well	Endrin	Lindane	Methoxychlor	Toxaphene	2,4-D	2,4,5-TP
Landfill No. 3	MW-113	ND	ND	0.0017	ND	ND	ND
	MW-114	0.00017	ND	ND	ND	ND	ND
	MW-115	ND	ND	0.00035	ND	ND	ND
	MW-215[a]	ND	ND	0.00033	ND	ND	ND
	FB-1[b]	ND	ND	ND	ND	ND	ND
North Landfill Zone							
Landfill No. 2	MW-125	ND	ND	ND	ND	ND	ND
	MW-126	ND	ND	0.00031	ND	ND	ND
	MW-127	ND	ND	ND	ND	0.00019	ND
	MW-128	ND	ND	ND	ND	ND	ND
	MW-129	ND	ND	ND	ND	ND	ND
Landfill No. 1	MW-130	0.00004	ND	ND	ND	ND	ND
	MW-230[a]	0.00007	0.00004	ND	ND	ND	ND
FTA-3	MW-131	ND	ND	ND	ND	ND	0.00025
	MW-132	ND	0.00002	ND	ND	0.00014	ND
FTA-2	MW-133	ND	0.00012	0.0011	ND	ND	ND
	MW-134	ND	ND	ND	ND	0.0001	0.00006
	Detection limit	0.00001	0.00002	0.0002	0.001	0.00006	0.00006

[a]Duplicate sample.
[b]Field blank.
ND - Not detected.

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Table 4-19

Herbicides/Pesticides (mg/L)

Travis Air Force Base
Fairfield, California
Analytical Results -- May 1985

Area/Zone	Staff Gauge or Monitor Well	Endrin	Lindane	Methoxychlor	Toxaphene	2,4-D	2,4,5-TP
Landfill No. 3	MW-113	ND	ND	ND	ND	0.00010	0.00009
	MW-114	0.00036	0.00002	ND	ND	ND	0.0018
	MW-115	ND	ND	ND	ND	ND	ND
	MW-215[a]	ND	ND	ND	ND	ND	0.00007
North Landfill Zone							
Landfill No. 2	MW-125	ND	0.00005	ND	ND	ND	ND
	MW-126	ND	ND	ND	ND	0.00037	0.00098
	MW-127	ND	ND	ND	ND	0.00025	0.00020
	MW-128	ND	ND	ND	ND	0.00007	ND
	MW-129	0.00005	ND	ND	ND	0.00014	ND
Landfill No. 1	MW-130	0.00004	0.00002	ND	ND	0.0014	ND
	MW-230[b]	0.00003	ND	ND	ND	ND	ND
FTA-3	MW-131	ND	0.00004	ND	ND	ND	ND
	MW-132	ND	0.00002	ND	ND	0.00019	ND
FTA-2	MW-133	ND	ND	ND	ND	0.00067	ND
	MW-134	ND	ND	ND	ND	0.00010	ND
	Detection limit	0.00001	0.00002	0.0002	0:001	0.00006	0.00006

[a]Duplicate sample.
ND - Not detected.

Table 4-20

Inorganic Compounds (mg/L)

Travis Air Force Base
Fairfield, California
Analytical Results -- March 1985

Area/Zone	Staff Gauge or Monitor Well	Alkalinity	Chloride	Nitrate	Sulfate	Total Dissolved Solids	Calcium	Magnesium	Sodium
Landfill No. 3	MW-113	210.	180.	14.	15.	860.	270.	36.	46.
	MW-114	200.	60.	33.	15.	460.	81.	11.	43.
	MW-115	200.	25.	18.	ND	360.	150.	20.	31.
	FB-1[a]	5.	ND	ND	ND	28.	ND	ND	ND
JP-4 Spill Area	MW-116	590.	420.	7.0	30.	1,400.	200.	62.	200.
	MW-216[b]	560.	420.	7.5	55.	1,300.	190.	50.	200.
	Detection limit	1.	0.5	0.1	10.	10.	0.05	0.005	0.01

[a]Field blank.
[b]Duplicate sample.
ND - Not detected.

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Table 4-21

Inorganic Compounds (mg/L)

Travis Air Force Base
Fairfield, California
Analytical Results -- May 1985

Area/Zone	Staff Gauge or Monitor Well	Alkalinity	Chloride	Nitrate	Sulfate	Total Dissolved Solids	Calcium	Magnesium	Sodium
Landfill No. 3	MW-113	210.	170.	14.	10.	740.	170.	37.	51.
	MW-114	200.	60.	30.	15.	560.	84.	14.	35.
	MW-115	230.	25.	15.	10.	390.	76.	11.	25.
JP-4 Spill Area	MW-116	600.	440.	7.0	25.	1,600.	210.	80.	190.
	MW-216[a]	620.	440.	7.7	25.	1,500.	210.	75.	200.
	Detection limit	1.	0.5	0.1	10.	10.	0.05	0.005	0.01

[a]Duplicate sample.

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Table 4-22

Soluble Metals (mg/L)

Travis Air Force Base
Fairfield, California
Analytical Results -- March/May 1985

Area/Zone	Staff Gauge or Monitor Well	Barium	Nickel	Mercury
Landfill No. 3	MW-113	0.200/0.700	ND/0.100	ND/ND
	MW-114	0.200/0.500	ND/0.100	ND/ND
	MW-115	ND/0.0400	ND/0.170	ND/ND
	MW-215[a]	0.200/0.500	ND/0.200	ND/ND
Sewage Treatment Plant Zone	MW-121	ND/0.300	NR/NR	ND/ND
	MW-122	ND/0.300	NR/NR	0.001/ND
	MW-123	0.300/1.200	NR/NR	ND/0.003
	MW-124	0.800/3.900	NR/NR	0.001/0.001
	SG-10	0.200/0.300	NR/NR	ND/ND
	SG-11	0.200/0.200	NR/NR	ND/ND
	SG-12	0.200/0.200	NR/NR	ND/ND
	Detection limit	0.100	0.050	0.001

[a] Duplicate sample
ND - Not detected.
NR - Not requested.

Table 4-23

Travis Air Force Base
Fairfield, California
Analytical Results -- March 1985

Area/Zone	Staff Gauge or Monitor Well	TOC (mg/L)	Petroleum Hydrocarbon (mg/L)
Landfill No. 3	MW-113	2.	NR
	MW-114	2.	NR
	MW-115	4.	NR
JP-4 Spill Area	MW-116	5.	0.5
	Detection limit	1.	0.2

ND - Not detected.
NR - Not requested.

Table 4-24

Travis Air Force Base
Fairfield, California
Analytical Results -- May 1985

Area/Zone	Staff Gauge or Monitor Well	TOC (mg/L)	Petroleum Hydrocarbon (mg/L)
Landfill No. 3	MW-113	7.	NR
	MW-114	34.	NR
	MW-115	16.	NR
JP-4 Spill Area	MW-116	6.	ND
	MW-216[a]	3.	NR
	Detection limit	1.	0.1

[a]Duplicate sample.
ND - Not detected.
NR - Not requested.

4.4.2.3 JP-4 Spill

Monitoring well MW-116 was utilized to monitor the groundwater in the area of the 1978 JP-4 spill. TCA is the only volatile organic detected and confirmed in both sampling rounds. Chloroform was identified in the second sampling round. No base/neutral or acid extractable compounds were detected in either sampling round. Tables 4-15, 4-16, 4-17, 4-20, 4-21, 4-23, and 4-24 summarize the water quality results for MW-116.

The potability factors at MW-116 are somewhat elevated in comparison to background values. Petroleum hydrocarbons were detected in the March 1985 sampling round. However, the top of the well screen is below the top of the water table (Figure 3-10), therefore, any floating hydrocarbons would not be caught in the well. Also, the spill ran into the drainage ditch adjacent to the site and may not have affected the groundwater.

Based on this investigation, the JP-4 Spill Area is unconfirmed as a contamination source. At least one more well needs to be installed in the area to catch any floating hydrocarbons and to assess if any contaminants are moving toward the drainage ditch through the groundwater.

4.4.2.4 Sewage Treatment Plant Zone

Four monitoring wells (MW-121 through MW-124) were installed to monitor the inactive Sewage Treatment Plant and the inactive oxidation ponds. MW-124 is upgradient of these areas, MW-123 is located between the plant and the ponds, and MW-121 and MW-122 are located downgradient of the ponds. Tables 4-25 through 4-33 list the analytical results.

The volatiles detected and confirmed in both sampling rounds in the Sewage Treatment Plant Zone (STPZ) include 1,1,1-trichloroethane, chloroform, and 1,2-dichloroethane. Also detected in the second sampling round was chlorobenzene. The chloroform, chlorobenzene, and 1,2-dichloroethane may be contaminants emanating from the inactive Sewage Treatment Plant and oxidation ponds. Traces of the base/neutral compounds fluoranthene and pyrene were identified in MW-121 during the March 1985 sampling. Pyrene is generally associated with coal tars, however, fluoranthene is found in domestic sewage. The existence of these compounds is not confirmed and, is therefore, questionable.

Table 4-25

Volatile Organic Compounds (mg/L)

Travis Air Force Base
Fairfield, California
Analytical Results -- March 1985

Area/Zone	Staff Gauge or Monitor Well	Benzene	1,1,1-Trichloroethane	Chloroform	Chlorobenzene	1,1,2,2-Tetrachloroethane	Trans-1,2-Dichloroethene	Tetrachloroethene	Trichloroethene	1,2-Dichloroethane	1,1-Dichloroethene
FTA-4	MW-117	ND	0.0075	ND	Tr	ND	ND	ND	ND	ND	ND
	MW-118	ND	0.0092	0.0035	Tr	ND	ND	ND	ND	ND	ND
	MW-119	ND	ND	ND	ND	ND	ND	ND	0.010	0.010	ND
	MW-120	ND	0.0053	0.0016	ND	ND	ND	ND	ND	ND	ND
	SG-13	ND	0.0079	0.0032	ND	ND	ND	ND	ND	ND	0.0006
	SG-14	0.0012	0.012	0.004	ND	ND	0.0033	ND	0.033	ND	ND
	SG-314[a]	0.0026	0.005	0.0022	ND	ND	0.0028	ND	0.035	ND	ND
	SG-15	0.0031	0.014	0.0049	ND	Tr	0.012	Tr	0.042	ND	ND
Sewage Treatment Plant Zone	MW-121	ND	0.0089	0.001	ND	ND	ND	ND	ND	0.0012	ND
	MW-122	ND	0.0075	ND	ND	ND	ND	ND	ND	ND	ND
	MW-123	ND	0.013	ND	0.0038	ND	ND	ND	ND	0.0006	ND
	MW-124	ND	0.013	ND	ND	ND	ND	ND	ND	ND	ND
	SG-10	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
	SG-11	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
	SG-12	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
	FB-3[b]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	Detection limit	0.001	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005

[a]Duplicate sample.
[b]Field blank (taken same date as monitor well samples).
ND - Not detected.
Tr - Trace -- detected below detection limit.
NR - Not requested.

Table 4-26

Volatile Organic Compounds (mg/L)

Travis Air Force Base
Fairfield, California
Analytical Results -- May 1985

Area/Zone	Staff Gauge or Monitor Well	1,1,1-Trichloroethane	Chloroform	Trichloroethene	1,2-Dichloroethane	Bromodichloromethane	Toluene	Benzene	Trans-1,2-dichloroethene	Bromoform	Chlorodibromomethane
FTA-4	MW-117	0.012	ND	ND	ND	ND	ND	ND	ND	ND	ND
	MW-118	0.0067	Tr	ND	0.0007	ND	ND	ND	ND	ND	ND
	MW-119	0.004	Tr	Tr	Tr	ND	ND	ND	ND	ND	ND
	MW-120	0.0068	ND	0.029	0.0029	ND	ND	ND	ND	ND	ND
	SG-13	ND	0.029	ND	ND	0.004	0.0006	ND	ND	ND	ND
	SG-14	ND	0.014	0.0071	ND	0.0041	Tr	0.001	0.0027	Tr	0.0009
	SG-314[a]	0.013	0.016	0.018	ND	0.005	Tr	Tr	0.002	ND	ND
	SG-15	0.011	0.012	0.0078	ND	0.0035	Tr	Tr	0.0026	Tr	0.0007
	FB-2[b]	0.012	0.0006	ND	ND	ND	ND	ND	ND	ND	ND
Sewage Treatment Plant Zone	MW-121	0.0074	0.0005	ND	0.0021	ND	ND	ND	ND	ND	ND
	MW-122	0.011	ND	ND	ND	ND	ND	ND	ND	ND	ND
	MW-123	0.020	Tr	ND	0.0036	ND	ND	ND	ND	ND	ND
	MW-124	0.0041	ND	ND	ND	ND	ND	ND	ND	ND	ND
	SG-10	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
	SG-11	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
	SG-12	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
	FB-1[b]	0.0067	0.014	ND	ND	0.0008	ND	ND	ND	ND	ND
	Detection limit	0.0005	0.0005	0.0005	0.0005	0.0005	0.001	0.001	0.0005	0.001	0.0005

[a]Duplicate sample.
[b]Field blank.
ND - Not detected.
Tr - Trace -- detected below detection limit.
NR - Not requested.

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Table 4-27

Base/Neutral Compounds (mg/L)

Travis Air Force Base
Fairfield, California
Analytical Results -- March 1985

Area/Zone	Staff Gauge or Monitor Well	Di-n-butyl Phthalate	Diethyl Phthalate	Fluor-anthene	Pyrene
FTA-4	MW-117	ND	Tr	Tr	Tr
	MW-118	ND	0.002	ND	ND
	MW-119	ND	ND	ND	ND
	MW-120	ND	Tr	ND	ND
	SG-13	0.007	ND	ND	ND
	SG-14	0.002	ND	ND	ND
	SG-314[a]	ND	ND	ND	ND
	SG-15	ND	ND	ND	ND
Sewage Treatment Plant Zone	MW-121	ND	ND	Tr	Tr
	MW-122	ND	ND	ND	ND
	MW-123	ND	ND	ND	ND
	MW-124	ND	ND	ND	ND
	SG-10	NR	NR	NR	NR
	SG-11	NR	NR	NR	NR
	SG-12	NR	NR	NR	NR
	FB-3[b]	ND	Tr	ND	ND
	Detection limit	0.002	0.002	0.002	0.001

[a]Duplicate sample.
[b]Field blank (taken same date as monitor well samples).
ND - Not detected.
Tr - Trace -- detected below detection limit.
NR - Not requested.

Table 4-28

Herbicides/Pesticides (mg/L)

Travis Air Force Base
Fairfield, California
Analytical Results -- March 1985

Area/Zone	Staff Gauge or Monitor Well	Endrin	Lindane	Methoxychlor	Toxaphene	2,4-D	2,4,5-TP
Sewage Treatment Plant Zone	MW-121	ND	ND	ND	ND	0.00006	ND
	MW-122	ND	ND	ND	ND	ND	ND
	MW-123	ND	ND	ND	ND	ND	ND
	MW-124	0.00002	0.00008	ND	ND	0.00006	0.00006
	SG-10	0.00004	0.00004	ND	ND	0.00015	ND
	SG-11	0.00005	0.00004	ND	ND	0.00015	ND
	SG-12	0.00006	0.00007	ND	ND	ND	ND
	Detection limit	0.00001	0.00002	0.0002	0.001	0.00006	0.00006

ND - Not detected.

Table 4-29

Herbicides/Pesticides (mg/L)

Travis Air Force Base
Fairfield, California
Analytical Results -- May 1985

Area/Zone	Staff Gauge or Monitor Well	Endrin	Lindane	Methoxychlor	Toxaphene	2,4-D	2,4,5-TP
Sewage Treatment Plant Zone	MW-121	0.00008	ND	ND	ND	0.00017	ND
	MW-122	ND	ND	ND	ND	0.00017	ND
	MW-123	0.00033	ND	ND	ND	0.0014	ND
	MW-124	0.00016	0.00002	ND	ND	ND	0.00017
	SG-10	0.00012	ND	ND	ND	ND	ND
	SG-11	0.00007	ND	ND	ND	0.00006	ND
	SG-12	0.00006	ND	ND	ND	ND	ND
	FB-1[a]	ND	ND	ND	ND	ND	ND
	Detection limit	0.00001	0.00002	0.0002	0.001	0.00006	0.00006

[a]Field blank.
ND - Not detected.

Table 4-30

Inorganic Compounds (mg/L)

Travis Air Force Base
Fairfield, California
Analytical Results -- March 1985

Area/Zone	Staff Gauge or Monitor Well	Alkalinity	Chloride	Nitrate	Sulfate	Total Dissolved Solids	Calcium	Magnesium	Sodium
FTA-4	MW-117	330.	800.	13.	120.	1,900.	160.	50.	300.
	MW-118	260.	1,700.	15.	45.	3,100.	230.	74.	430.
	MW-119	450.	250.	3.7	50.	2,200.	56.	28.	280.
	MW-120	450.	980.	14.	100.	2,300.	240.	86.	350.
	SG-13	190.	540.	3.7	60.	1,100.	67.	26.	320.
	SG-14	240.	500.	3.6	65.	1,100.	67.	26.	310.
	SG-314[a]	220.	510.	3.6	70.	1,100.	64.	27.	300.
	SG-15	230.	460.	3.7	70.	1,000.	64.	26.	290.
Sewage Treatment Plant Zone	MW-121	420.	100.	350.	130.	1,300.	53.	32.	300.
	MW-122	420.	360.	11.	100.	1,300.	41.	22.	340.
	MW-123	190.	1,200.	74.	85.	2,700.	180.	74.	330.
	MW-223[a]	180.	1,000.	73	95.	2,300.	160.	97.	390.
	MW-124	200.	3,500.	10.	40.	6,400.	260.	86.	850.
	SG-10	NR	NR	NR	NR	NR	NR	NR	NR
	SG-11	NR	NR	NR	NR	NR	NR	NR	NR
	SG-12	NR	NR	NR	NR	NR	NR	NR	NR
	FB-3	5.	10.	8.4	ND	ND	2.5	ND	ND
	Detection limit	1.	0.5	0.1	10.	10.	0.05	0.005	0.01

[a]Duplicate sample.
ND - Not detected.
NR - Not requested.

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Table 4-31

Inorganic Compounds (mg/L)

Travis Air Force Base
Fairfield, California
Analytical Results -- May 1985

Area/Zone	Staff Gauge or Monitor Well	Alkalinity	Chloride	Nitrate	Sulfate	Total Dissolved Solids	Calcium	Magnesium	Sodium
FTA-4	MW-117	380.	740.	14.	140.	2,000.	150.	70.	480.
	MW-118	250.	2,000.	17.	25.	3,800.	300.	120.	850.
	MW-119	470.	310.	5.0	30.	1,200.	51.	25.	280.
	MW-120	570.	1,000.	13.	110.	2,600.	210.	75.	650.
	SG-13	230.	220.	6.0	19.	740.	44.	27.	140.
	SG-14	220.	220.	5.1	19.	690.	45.	26.	140.
	SG-314[a]	210.	220.	5.2	61.	670.	44.	26.	140.
	SG-15	230.	220.	5.0	13.	700.	46.	26.	150.
	FB-2[b]	ND	ND	2.6	ND	190.	ND	ND	ND
Sewage Treatment Plant Zone	MW-121	440.	120.	250.	120.	1,300.	58.	28.	290.
	MW-122	470.	300.	25.	86.	1,200.	40.	19.	310.
	MW-123	190.	1,200.	25.	65.	2,900.	160.	80.	700.
	MW-223[a]	180.	1,400.	65.	56.	2,900.	160.	85.	650.
	MW-124	220.	5,100.	7.6	15.	7,600.	300.	85.	2,300.
	SG-10	NR	NR	NR	NR	NR	NR	NR	NR
	SG-11	NR	NR	NR	NR	NR	NR	NR	NR
	SG-12	NR	NR	NR	NR	NR	NR	NR	NR
	FB-1[b]	ND	ND	1.0	ND	32.	ND	ND	ND
	Detection limit	1.	0.5	0.1	10.	10.	0.05	0.005	0.01

[a]Duplicate sample.
[b]Field blank.
ND - Not detected.
NR - Not reported.

WESTON

Table 4-32

Travis Air Force Base
Fairfield, California
Analytical Results -- March 1985

Area/Zone	Staff Gauge or Monitor Well	TOC (mg/L)	Phenols (mg/L)	Petroleum Hydrocarbon (mg/L)
FTA-4	MW-117	17.	ND	1.1
	MW-118	10.	ND	1.1
	MW-119	8.	ND	1.1
	MW-120	46.	ND	0.6
	SG-13	6.	ND	NR
	SG-14	5.	ND	NR
	SG-314[a]	6.	ND	NR
	SG-15	6.	ND	NR
Sewage Treatment Plant Zone	MW-121	10.	ND	NR
	MW-122	11.	ND	NR
	MW-123	3.	ND	NR
	MW-223[a]	4.	ND	NR
	MW-124	4.	ND	NR
	SG-10	NR	NR	NR
	SG-11	NR	NR	NR
	SG-12	NR	NR	NR
	FB-3[b]	ND	ND	0.6
	Detection limit	1.0	0.1	0.2

[a]Duplicate sample.

[b]Field blank (taken same date as monitor well samples).
ND - Not detected.
NR - Not requested.

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Table 4-33

Travis Air Force Base
Fairfield, California
Analytical Results -- May 1985

Area/Zone	Staff Gauge or Monitor Well	TOC (mg/L)	Phenols (mg/L)	Petroleum Hydrocarbon (mg/L)
FTA-4	MW-117	28.	ND	0.85
	MW-118	19.	ND	ND
	MW-119	10.	ND	0.69
	MW-120	13.	ND	1.1
	SG-13	2.	ND	NR
	SG-14	4.	ND	NR
	SG-314[a]	4.	ND	NR
	SG-15	4.	ND	NR
Sewage Treatment Plant Zone	MW-121	11.	ND	NR
	MW-122	14.	ND	NR
	MW-123	11.	ND	NR
	MW-223[a]	9.	ND	NR
	MW-124	10.	ND	NR
	SG-10	NR	NR	NR
	SG-11	NR	NR	NR
	SG-12	NR	NR	NR
	Detection limit	1.0	0.1	0.1

[a]Duplicate sample.
ND - Not detected.
NR - Not requested.

The pesticides endrin and lindane, and the herbicides 2,4-D and 2,4,5-TP were detected and confirmed for both sampling rounds. The majority of the contaminants were found in the upgradient well MW-124. Only 2,4-D was confirmed in downgradient well MW-121. This implies that the pesticides and perhaps the herbicides detected emanate from somewhere upgradient of the STPZ. These could also be a result of the current application of pesticides and herbicides around the Base.

Potability factors exhibit elevated concentrations compared to background. Although chlorides, TDS, calcium, magnesium, and sodium have higher concentrations in the upgradient well, MW-124, the concentrations of nitrates, sulfates, and alkalinity increase dramatically as you move downgradient. This indicates that leakage has occurred from the Sewage Treatment Plant and oxidation ponds in the past.

Metals were analyzed and the results are listed on Table K-16. Barium and mercury were detected with mercury exceeding the State Action Level once in MW-123. The highest concentrations of barium occur in MW-124, the upgradient well, implying an upgradient source.

TOC concentrations ranged from 3 mg/L to 14 mg/L. No phenols were detected in either sampling round.

The results of this investigation indicate that the inactive Sewage Treatment Plant and oxidation ponds are impacting the groundwater quality. Due to the elevated concentrations in MW-121, it appears that the contamination may be moving off-Base.

4.4.2.5 Fire Training Area No. 4

Results of analyses for FTA-4 are listed in Tables 4-25 through 4-27 and 4-30 through 4-33. The volatile compounds 1,1,1-trichloroethane, chloroform, TCE, and 1,2-dichloroethane were identified and confirmed in both sampling rounds. The solvents may be remnants of waste solvents utilized for fire training until the early 1970's. Chloroform is utilized in fire extinguishers and the 1,1,1-trichloroethane is a solvent utilized in cold-type metal cleaning. Chlorobenzene was the only other volatile identified. The base/neutral compounds pyrene, fluoranthene, and diethyl phthalate were identified in the March 1985 sampling.

Potability factors are generally elevated compared to background. The concentrations are somewhat higher in wells MW-117 and MW-118, the wells closest to Union Creek and upgradient of the site. Since Union Creek is an influent stream at this point, the high concentrations may be due to the surface-water impacting the groundwater. This will be discussed further in Subsection 4.5.

TOC concentrations ranged from 8 mg/L to 46 mg/L. In addition, petroleum hydrocarbons were detected and confirmed for wells MW-117, MW-119, and MW-120. The TOC concentrations may reflect the presence of the petroleum hydrocarbons, however, the levels do not correspond. The petroleum hydrocarbons are probably a result of the utilization of waste oils and fuels for fire training exercises. No phenols were detected or identified in any samples.

Based on the results of this investigation, it appears that the waste solvents, fuels, and oils utilized in fire training exercises have impacted and, may be presently impacting, the groundwater beneath the site.

4.4.2.6 North Landfill Zone

Ten monitoring wells (MW-125 through MW-134) were installed to test the groundwater in the NLFZ. The analytical results are listed in Tables 4-18, 4-19, and 4-34 through 4-41.

4.4.2.6.1 Landfill No. 1

Monitoring well MW-130 was utilized to sample groundwater downgradient of Landfill No. 1. TCE was detected and confirmed in both sampling rounds in concentrations ranging from 0.0018 mg/L to 0.0067 mg/L. Since TCE is not detected in wells around Landfill No. 2 and MW-130 is also somewhat downgradient of that landfill, it appears that Landfill No. 1 is the source of TCE in MW-130. In the second sampling round, 1,1,1-trichloroethane was detected. The base/neutral compound di-n-butyl phthalate was detected in March. No acid extractables were detected in either sampling round.

Potability factors are within background ranges, except TDS, which is slightly elevated. Barium was detected in May 1985 at 0.2 mg/L. The TOC concentration in both March and May was below 10 mg/L. No phenols were detected in either sampling round.

Table 4-34

Volatile Organic Compounds (mg/L)

Travis Air Force Base
Fairfield, California
Analytical Results -- March 1985

Area/Zone	Staff Gauge or Monitor Well	1,1,1-Trichloroethane	Chloroform	Chlorobenzene	Trans-1,2-dichloroethene	Trichloroethene	Bromodichloromethane	1,1-Dichloroethane
North Landfill Zone								
Landfill No. 2	MW-125	ND	ND	ND	ND	ND	ND	ND
	MW-126	ND	ND	0.0097	ND	ND	ND	0.0010
	MW-127	ND	ND	ND	ND	ND	ND	ND
	MW-128	ND	ND	ND	ND	ND	ND	ND
	MW-129	ND	ND	ND	ND	ND	ND	ND
Landfill No. 1	MW-130	ND	ND	ND	ND	0.0067	ND	ND
	MW-230[a]	ND	ND	ND	ND	0.0064	ND	ND
FTA-3	MW-131	0.0093	ND	ND	ND	0.020	ND	ND
	MW-132	0.010	0.0005	ND	Tr	0.029	Tr	ND
FTA-2	MW-133	0.012	ND	ND	ND	ND	ND	ND
	MW-134	0.0093	ND	ND	ND	ND	ND	ND
	Detection limit	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005

[a]Duplicate sample.
ND - Not detected.
Tr - Trace -- Detected below detection limit.

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Table 4-35

Volatile Organic Compounds (mg/L)

Travis Air Force Base
Fairfield, California
Analytical Results -- May 1985

Area/Zone	Staff Gauge or Monitor Well	1,1,1-Trichloroethane	Chloroform	Chlorobenzene	Trans-1,2-dichloroethene	Trichloroethene	1,1-Dichloroethane	1,2-Dichloroethane
North Landfill Zone								
Landfill No. 2	MW-125	0.0081	ND	Tr	ND	ND	ND	ND
	MW-126	0.0082	Tr	0.0045	ND	ND	0.0005	ND
	MW-127	0.0085	Tr	Tr	ND	ND	ND	ND
	MW-128	0.0054	ND	Tr	ND	ND	ND	ND
	MW-129	0.0068	ND	ND	ND	Tr	ND	ND
Landfill No. 1	MW-130	0.0093	ND	ND	ND	0.0018	ND	ND
	MW-230[a]	0.014	ND	ND	ND	0.0041	ND	ND
FTA-3	MW-131	0.011	0.0007	ND	ND	0.004	ND	0.0013
	MW-132	ND	0.0005	ND	0.0011	0.0062	ND	0.005
FTA-2	MW-133	0.015	ND	ND	ND	ND	ND	ND
	MW-134	0.017	ND	ND	ND	ND	ND	ND
	Detection limit	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005

[a]Duplicate sample.
ND - Not detected.
Tr - Trace -- Detected below detection limit.

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Table 4-36

Base/Neutral Compounds (mg/L)

Travis Air Force Base
Fairfield, California
Analytical Results -- March 1985

Area/Zone	Staff Gauge or Monitor Well	Di-n-butyl Phthalate	Diethyl Phthalate
North Landfill Zone			
Landfill No. 2	MW-125	ND	ND
	MW-126	ND	ND
	MW-127	ND	ND
	MW-128	ND	ND
	MW-129	0.002	ND
Landfill No. 1	MW-130	0.005	ND
	MW-230[a]	Tr	ND
FTA-3	MW-131	0.004	ND
	MW-132	0.003	ND
FTA-2	MW-133	ND	Tr
	MW-134	ND	ND
	Detection limit	0.002	0.002

[a]Duplicate sample.
ND - Not detected.
Tr - Trace -- Detected below detection limit.

Table 4-37

Inorganic Compounds (mg/L)

Travis Air Force Base
Fairfield, California
Analytical Results -- March 1985

Area/Zone	Staff Gauge or Monitor Well	Alkalinity	Chloride	Nitrate	Sulfate	Total Dissolved Solids	Calcium	Magnesium	Sodium
North Landfill Zone									
Landfill No. 2	MW-125	1,300.	490.	11.	810.	2,400.	300.	120.	270.
	MW-126	340.	560.	5.7	3,400.	7,200.	440.	330.	800.
	MW-127	150.	4,600.	6.6	2,400.	12,000.	980.	730.	680.
	MW-128	430.	310.	30.	1,900.	3,900.	84.	130.	580.
	MW-129	350.	450.	15.	150.	1,400.	130.	86.	280.
Landfill No. 1	MW-130	330.	270.	11.	200.	1,000.	84.	170.	220.
	MW-230[a]	350.	250.	11.	200.	1,100.	87.	40.	220.
FTA-3	MW-131	220.	1,200.	0.7	930.	3,700.	440.	200.	320.
	MW-132	540.	830.	2.8	1,600.	4,300.	570.	160.	470.
FTA-2	MW-133	740.	120.	1.8	100.	1,000.	44.	23.	310.
	MW-134	460.	370.	4.2	70.	1,100.	90.	41.	280.
	Detection limit	1.	0.5	0.1	10.	10.	0.05	0.005	0.01

[a]Duplicate sample.

Table 4-38

Inorganic Compounds (mg/L)

Travis Air Force Base
Fairfield, California
Analytical Results -- May 1985

Area/Zone	Staff Gauge or Monitor Well	Alkalinity	Chloride	Nitrate	Sulfate	Total Dissolved Solids	Calcium	Magnesium	Sodium
North Landfill Zone									
Landfill No. 2	MW-125	270.[a]	530.	11.	900.	2,800.	350.	140.	270.
	MW-126	1,300[a]	480.	3.7	3,700.	7,700.	470.	360.	1,600.
	MW-127	170.	4,500.	4.4	2,400.	12,000.	1,000.	800.	1,700.
	MW-128	440.	300.	23.	1,800.	3,900.	89.	140.	1,000.
	MW-129	350.	450.	26.	210.	1,700.	110.	90.	270.
Landfill No. 1	MW-130	330.	270.	8.1	200.	1,300.	76.	75.	210.
	MW-230[b]	320.	270.	8.1	200.	1,200.	76.	75.	220.
FTA-3	MW-131	260.	1,300.	0.5	930.	4,100.	400.	230.	800.
	MW-132	510.	850.	2.3	1,500.	4,800.	540.	170.	900.
FTA-4	MW-133	660.	90.	0.1	73.	1,100.	50.	31.	260.
	MW-134	480.	370.	2.6	55.	1,400.	84.	42.	270.
	Detection limit	1.	0.5	0.1	10.	10.	0.05	0.005	0.01

[a]Field samples or lab aliquots may have been switched.
[b]Duplicate sample.

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Table 4-39

Soluble Metals (mg/L)

Travis Air Force Base
Fairfield, California
Analytical Results -- March/May 1985

Area/Zone	Staff Gauge or Monitor Well	Barium	Lead	Nickel	Selenium	Zinc
North Landfill Zone						
Landfill No. 2	MW-125	ND/0.200	ND/ND	ND/ND	ND/ND	ND/ND
	MW-126	ND/0.300	ND/ND	ND/ND	ND/ND	ND/ND
	MW-127	ND/0.200	0.020/ND	ND/0.100	ND/0.050	0.130/0.050
	MW-128	ND/ND	ND/ND	ND/ND	ND/ND	ND/ND
	MW-129	ND/0.200	ND/ND	ND/ND	ND/ND	ND/ND
Landfill No. 1	MW-130	ND/0.200	ND/ND	ND/ND	ND/ND	ND/ND
	MW-230[a]	ND/0.200	ND/ND	ND/ND	ND/ND	ND/ND
	Detection limit	0.100	0.100	0.050	0.001	0.010

[a]Duplicate sample.
ND - Not detected.

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Table 4-40

Travis Air Force Base
Fairfield, California
Analytical Results -- March 1985

Area/Zone	Staff Gauge or Monitor Well	TOC (mg/L)	Phenols (mg/L)	Petroleum Hydrocarbon (mg/L)
North Landfill Zone				
Landfill No. 2	MW-125	3.	ND	NR
	MW-126	16.	ND	NR
	MW-127	11.	ND	NR
	MW-128	2.	ND	NR
	MW-129	10.	ND	NR
Landfill No. 1	MW-130	5.	ND	NR
	MW-230[a]	3.	ND	NR
FTA-3	MW-131	4.	ND	0.6
	MW-132	4.	ND	0.4
FTA-2	MW-133	2.	ND	0.5
	MW-134	8.	ND	1.1
	Detection limit	1.	0.1	0.2

[a]Duplicate sample.
ND - Not detected.
NR - Not requested.

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Table 4-41

Travis Air Force Base
Fairfield, California
Analytical Results -- May 1985

Area/Zone	Staff Gauge or Monitor Well	TOC (mg/L)	Phenols (mg/L)	Petroleum Hydrocarbon (mg/L)
North Landfill Zone				
Landfill No. 2	MW-125	5.	ND	NR
	MW-126	22.	ND	NR
	MW-127	30.	ND	NR
	MW-128	12.	ND	NR
	MW-129	8.	ND	NR
Landfill No. 1	MW-130	7.	ND	NR
	MW-230[a]	6.	ND	NR
FTA-3	MW-131	1.	ND	0.54
	MW-132	12.	ND	1.0
FTA-2	MW-133	7.	ND	0.79
	MW-134	2.	ND	0.40
	Detection limit	1.	0.1	0.1

[a]Duplicate sample.
ND - Not detected.
NR - Not requested.

Based on the results of this investigation, Landfill No. 1 is contributing TCE to the groundwater at levels close to the California Action Level of 0.005 mg/L. Other impacts appear to be minor.

4.4.2.6.2 Landfill No. 2

Five monitoring wells (MW-125 through MW-129) were installed around Landfill No. 2. MW-125 and MW-126 are upgradient of the landfill, and MW-127 through MW-129 are downgradient. Only two volatile compounds were detected and confirmed in both sampling rounds in MW-126, chlorobenzene and 1,1-dichloroethane.

In the second sampling round 1,1,1-trichloroethane, chloroform, and TCE were also identified. The presence of the confirmed compounds in an upgradient well indicates a possible off-site source. Since these compounds are not detected in the downgradient wells, it is doubtful that the compounds found resulted from mounding of the water table in the landfill.

The base/neutral compound di-n-butyl phthalate was detected in MW-129 in the first sampling round. No acid extractables were detected or identified in either round.

Potability factors were elevated compared to background. MW-127, a downgradient well, exhibited the most elevated concentrations of chlorides, TDS, calcium, magnesium, and sodium. Other downgradient wells contained lower concentrations and in some cases, less than upgradient well concentrations. Only zinc was detected and confirmed in both sampling rounds in MW-127. Other metals detected in one sampling round included barium, lead, nickel, and selenium. The selenium concentration exceeded the Federal Drinking Water Standard of 0.01 mg/L.

TOC concentrations ranged from 2 mg/L to 30 mg/L. TOC was highest in upgradient well MW-126 and downgradient well MW-127. No phenols were detected in either round.

Based on this investigation, it appears that Landfill No. 2 is contributing a small amount of contaminants to the groundwater, mainly inorganics. There may be an off-site contamination source north of the Base.

4.4.2.6.3 Fire Training Area No. 2

Monitoring wells MW-133 and MW-134 were installed to sample groundwater downgradient of FTA-2. 1,1,1-trichloroethane was the only VOC detected and confirmed in both sampling rounds. The 1,1,1-trichloroethane is probably a result of waste solvents used to fuel fires for training exercises. A trace amount of the base/neutral compound diethyl phthalate was identified in the March sampling round. No acid extractables were found in either round.

Potability factors were slightly elevated above background levels in both sampling rounds, however, the concentrations do not indicate inorganic contamination from FTA-2.

TOC concentrations were below the 10 mg/L background level, and no phenols were detected in either sampling round. Petroleum hydrocarbons were detected at concentrations ranging from 0.5 to 1.1 mg/L. These compounds are probably a result of the use of waste oils and fuels to fuel fires for training exercises.

Based on the results of this investigation, Fire Training Area No. 2 appears to be contributing a small amount of 1,1,1-trichloroethane and petroleum hydrocarbon compounds to the groundwater. The 1,1,1-trichloroethane concentrations do not exceed California Action Levels.

4.4.2.6.4 Fire Training Area No. 3

Two monitoring wells (MW-131 and MW-132) were installed to sample groundwater downgradient of FTA-3. Four volatile compounds were detected and confirmed in both sampling rounds; 1,1,1-trichloroethane, TCE, chloroform, and trans-1,2-dichloroethene. The 1,1,1-trichloroethane, TCE, and trans-1,2-dichloroethene are all solvents that may have been utilized to fuel fires for training exercises. Chloroform is found in fire extinguishers. The only other volatile compound identified was bromodichloromethane in the first sampling round. This compound is a solvent and also an ingredient of fire extinguisher fluids. The base/neutral compound di-n-butyl phthalate was detected in the March 1985 sampling. No acid extractables were detected in either sampling round.

Potability factors tend to be elevated over background, particularly chlorides, sulfates, TDS, calcium, magnesium, and sodium. These wells are also downgradient of Landfill No. 2 and may be impacted by contaminants from that site.

TOC concentrations ranged from 1 to 12 mg/L, and petroleum hydrocarbons from 0.4 to 1.0 mg/L. These concentrations probably are a result of the use of waste fuels and oils in this area. No phenols were detected in either sampling round.

Based on this investigation, Fire Training Area No. 3 is contributing 1,1,1-trichloroethane, TCE, chloroform, and trans-1,2-dichloroethene to the groundwater. TCE is the only compound to exceed California Action Levels.

4.4.3 Summary of Groundwater Quality Results

The purpose of a Phase II, Stage 1, IRP study is to establish the presence or absence of contamination resulting from a potential source site. The results of the groundwater quality investigation are summarized in Table 4-42 in terms of the confirmation objective. Of the 12 investigation sites at Travis AFB, all except one were shown to be impacting the groundwater to differing extents. At one site, at least one additional monitoring well is needed to confirm the presence or absence of contamination. At three sites, two additional monitoring wells each are needed to further evaluate the extent and magnitude of contamination. At the remaining eight sites, the quality of shallow groundwater has been impacted by the site.

A variety of constituents exceeded their respective Federal or State standards, including benzene, 1,1,1-trichloroethane, PCE, TCE, 1,2-dichloroethane, 1,1-dichloroethene, chlorobenzene, nitrates, mercury, selenium, endrin, and phenols. Chlorides, sulfates, and TDS have been discounted due to the high concentrations occurring naturally.

Table 4-42

Summary of the Evaluation of Groundwater Quality Results

Zone/Area	Site has Impacted Shallow Groundwater			Number of Wells Required to Complete Confirmation Study
	Yes	No	Not Enough Information	
Storm Sewer Zone				
FTA-1	X			
Oil Spill	X			2
Solvent Spill	X			2
Sewer Right-of-Way	X			
Sewage Treatment Plant Zone	X			
FTA-4	X			
North Landfill Zone				
LF-1	X			
LF-2	X			
FTA-2	X			
FTA-3	X			2
Landfill No. 3	X			
JP-4 Spill Site			X	1

4.5 WATER QUALITY RESULTS FOR SURFACE WATER

This subsection reviews the chemical data obtained from surface-water and stormwater samples collected at Travis AFB in March and May 1985. Sampling stations designated SG-1 through SG-9 and SG-16 through SG-18 were established along the contaminated storm sewer and Union Creek where the storm sewers empty. SG-10 through SG-12 were established to monitor surface water potentially affected by the inactive Sewage Treatment Plant. SG-13 through SG-15 were established to monitor surface water potentially affected by FTA-4.

The methods used in surface-water sampling are outlined in Section 3 and further described in the Field Sampling and QA/QC Plan (Appendix H). All surface-water samples were collected as grab samples within a few feet of the shore. Samples were field filtered for metals analyses, and pH, temperature, and specific conductivity were measured within 6 hours of sample collection. The sampling round in March followed a period of rainy weather. The May sampling round was conducted during a period of almost no precipitation.

The water quality data are summarized in Tables 4-7 through 4-14, 4-22, and 4-25 through 4-33. The subsections that follow provide an evaluation of the data on the basis of criteria and water quality standards established in earlier sections.

4.5.1 Data Review

In general, the subsection observations made for groundwater data in Subsection 4.4.1.1 also apply to surface water. However, conditions affecting surface water are much more variable over short periods of time than those affecting groundwater; therefore, more contrast generally occurs between sampling rounds and between duplicate samples. Comparison of results between rounds cannot be used to confirm the presence of a parameter. Significant concentrations of naturally-occurring organic compounds are found in surface waters, and may affect indicator parameters such as TOC. For comparison purposes, the same criteria and standards were used for surface water as for groundwater. The subsections that follow will evaluate the analytical results on a site-by-site basis.

4.5.1.1 Storm Sewer Zone

Eight storm drains (SG-2 through SG-8 and SG-8A) and five stream locations (SG-1, SG-9, SG-16 through SG-18) were sampled to evaluate the sources of contamination in the storm sewers. Numerous volatile organic compounds were detected or identified, including benzene, 1,1,1-trichloroethane, chloroform, toluene, chlorobenzene, 1,1,2,2-tetrachloroethane, trans-1,2-dichloroethene, PCE, TCE, bromodichloromethane, ethylbenzene, bromoform, chlorodibromomethane, and 1,1-dichloroethene.

In the first sampling round, 1,1,1-trichloroethane, was detected entering the Base in Union Creek at SG-1. Within the storm sewer system itself SG-3, SG-4, SG-6, SG-7, and SG-8 all contained at least three volatile compounds exceeding State standards. Concentrations of volatiles in the storm drains were significantly higher than concentrations of the same compound in nearby wells, indicating that the storm sewer is the source of contamination to the groundwater. Various volatile compounds were detected at SG-18, located where the creek flows off-Base. TCE and 1,1-dichloroethene exceeded the State Action Level during one sampling round.

The groundwater elevations in the wells are higher than water elevations in the storm drains, allowing groundwater to flow toward the storm drains. This situation would imply that the source of contamination to the storm drains is the groundwater. However, during heavy rainfall Union Creek has been observed to rise 4 to 5 feet due to runoff from the Base. The water levels in the storm sewers also rise and become higher than the groundwater elevations. At this time the water in the storm sewers can flow into the groundwater. In addition, a leak or crack in a storm sewer pipe would allow contaminated water to impact the groundwater.

Base/neutral compounds were identified in SG-3, SG-4, SG-5, SG-7, and SG-8, the most prevalent being di-n-butyl phthalate. Other compounds detected included hexachloroethane, 1,2-dichlorobenzene, 1,3-dichlorobenzene, and 1,4-dichlorobenzene. No acid extractables were detected.

Potability factors were generally within the background ranges for groundwater. The parameter concentrations tended to increase downstream. TOC concentrations varied from 3 to 11 mg/L and followed no increasing or decreasing pattern. Phenols were detected in SG-3 and SG-9.

The same general patterns within parameters was exhibited in the second sampling round. Volatile compounds followed no definitive trend as far as increasing or decreasing in the second round. Additional compounds identified in the second round included bromoform and chlorodibromomethane. Within the storm sewer system itself, potability factors increased in the second round, whereas, a decrease was exhibited in Union Creek. TOC concentrations tended to increase and no phenols were detected.

Based on the results of this investigation, the storm sewer system is contaminated with various volatile organic compounds. This contamination appears to be impacting the surrounding groundwater. A more intensive study including more sampling points and flow weirs needs to be undertaken in order to define the sources.

4.5.1.2 Sewage Treatment Plant Zone

Three locations (SG-10 through SG-12) were established along Union Creek near the former Sewage Treatment Plant outfall in order to monitor the potential effects of the STPZ on the creek. Only pesticides and herbicides, and primary heavy metals were analyzed. The results of these analyses are listed in Tables 4-22, 4-28, and 4-29.

The pesticide endrin and the herbicide 2,4-D were detected in both sampling rounds. Lindane and 2,4,5-TP were detected in the first sampling round. None of the concentrations exceeded Federal standards.

The metal barium was detected in both sampling rounds at concentrations ranging from 0.2 to 0.3 mg/L, below Federal standards.

In this area, Union Creek is an effluent stream, receiving groundwater discharge. The detected parameters were also found in groundwater in the STPZ, therefore, the groundwater may be contributing the contaminants to the stream. The pesticides and herbicides could be originating from overland runoff. Based on this investigation, the Sewage Treatment Plant Zone appears to be impacting Union Creek.

4.5.1.3 Fire Training Area No. 4

Analytical results for staff gauges in FTA-4 are included in Tables 4-25 through 4-27 and 4-30 through 4-33. Three locations (SG-13 through SG-15) were established along Union Creek near FTA-4.

In the first sampling round, the volatile compounds benzene, 1,1,1-trichloroethane, chloroform, 1,1,2,2-tetrachloroethane, trans-1,2-dichloroethene, PCE, TCE, and 1,1-dichloroethene were identified or detected. SG-14 and SG-15 are located where Union Creek and the storm sewer outfall meet and just downstream. None of the volatile organics except 1,1,1-trichloroethane, chloroform, and 1,1-dichloroethene were detected in SG-13, which is located upsteam of the storm sewer outfall. This implies that the source of these volatiles is the storm sewer where they were also detected (Subsection 4.5.1.1). The base/neutral compound di-n-butyl phthalate was also detected in the first round. No acid extractables were detected.

Potability factors were generally within the background ranges for groundwater, except chloride, TDS, and sodium, which are somewhat elevated. TOC concentrations ranged from 5 to 6 mg/L. No phenols were detected.

The second round sampling detected or identified most of the same volatile organics as in the first round, with the addition of bromodichloromethane, bromoform, and chlorodibromomethane. These three compounds are trihalomethanes and are utilized in fire extinguishing agents. Their appearance in the second sampling round indicates that fire training exercises may have been conducted shortly before sampling, and overland runoff of the fire extinguishing agents has occurred. No base/neutral or acid extractable compounds were detected in the second round.

Potability factors remained within background ranges with the chloride, TDS, and sodium concentrations decreasing. TOC concentrations decreased to 2 to 4 mg/L, and no phenols were detected.

Along this portion of Union Creek, the creek is influent, contributing surface water to the groundwater. Many of the volatiles detected were found at points beyond the storm sewer outfall, indicating the storm sewer as the probable source. Based on this investigation it appears that FTA-4 is contributing a small amount of contaminants to the stream, mainly from overland runoff of fire extinguishing agents. These trihalomethanes did not exceed Federal standards.

4.5.2 Federal and State Water Quality Standards

Of the water quality standards listed in Table 4-6, the following were exceeded at least once in one storm drain or creek location: benzene, toluene, PCE, TCE, 1,1-dichloroethene, chlorobenzene, trans-1,2-dichloroethene, pH, TDS, chlorides, and phenols. Ignoring the TDS and chloride levels, which occur naturally above the standards, the main contaminants are organic compounds.

4.5.3 Summary of Surface-Water Quality Results

The purpose of the surface-water investigation in this Phase II, Stage 1 IRP Study is the same as for groundwater; to establish the presence or absence of contamination resulting from a potential source site. All three sites investigated were found to be contributing some contaminants to the creek. The storm sewer system is by far contributing the most and highest concentrations of contaminants, mainly volatile organics. An intensive study of the storm sewer system and creek needs to be undertaken in order to identify the sources of contaminants to the sewer and creek.

4.6 CONCLUSIONS

The subsections that follow discuss the conclusions related to the confirmation stage investigation of six zones/areas encompassing 12 potential contaminant source sites at Travis AFB. The first two subsections review general conclusions that have been drawn from this investigation concerning hydrogeology, and soil and water quality. The third subsection classifies the sites by category according to the need for further investigation and/or remediation. Investigation alternatives are reviewed in Section 5, and specific recommendations for each site are detailed in Section 6.

4.6.1 General Conclusions -- Hydrogeology

The following are general conclusions concerning the regional geological and hydrogeological settings at Travis AFB:

- The shallow aquifer underlying the Base is made up of fine sands, silts, and clays. Due to the low permeability of the sediments, the aquifer is not a major water producer at Travis or in the area surrounding the Base.

- The groundwater flow direction in the shallow aquifer beneath Travis AFB is toward the south, toward Suisun Marsh and Bay. Flow directions are not substantially affected by pumping of domestic, stock, and irrigation wells south of the Base.

- The natural water quality in the area near Travis AFB has been termed "marginal" due to the elevated levels of TDS and chlorides.

4.6.2 General Conclusions -- Soil and Water Quality

The following are general conclusions concerning soil and water quality data collected at Travis AFB in the course of this investigation:

- All of the sites (FTA-1, Oil Spill Area, Solvent Spill Area, FTA-4, FTA-2, FTA-3, STPZ) where soil and/or sediment samples were collected exhibited elevated levels of oil and grease or petroleum hydrocarbons. The highest concentration of oil and grease, 24,000 mg/kg occurred in Union Creek at SG-15, in a sample collected from 4- to 8-inches below ground surface. Within the soil borings, the highest concentration of oil and grease was found in a duplicate sample in the

0 to 1.5-foot interval at MW-103, equal to 5,500 mg/kg. The original sample concentration was 4,500 mg/kg. The highest petroleum hydrocarbon concentration occurred in the 0 to 1.5-foot interval sample at MW-118, equal to 16,000 mg/kg. Volatile organics were also analyzed in the soils and sediments. The highest sediment concentration was 3.4 mg/kg of ethylbenzene in the 8- to 12-inch interval in SG-9. The highest soil concentration occurred in the 0 to 1.5-foot interval at MW-133 where 0.0038 mg/kg of TCE was detected. It can be concluded that the soils and sediments at Travis AFB have been impacted by past disposal practices. Petroleum hydrocarbons will continue to accumulate at FTA-4 since this is an active fire training area utilizing waste fuels and oils.

- Of the analytes sampled in the storm drains and Union Creek many volatile organic compounds exceeded State Action Levels. The major source of contaminants appears to be the storm sewer system itself.

- Chlorides, TDS, sulfates, nitrates, mercury, and selenium are inorganic compounds whose standards were exceeded in groundwater. Of these, chlorides and TDS are known to occur naturally above their standards.

- Of the volatiles sampled in groundwater, TCE had the most exceedances of the State Action Level. No major plume is exhibited, implying that individual sources rather than one major source are contributing TCE to the groundwater. Other volatiles with exceedances in groundwater include: benzene, 1,1,1-trichloroethane, PCE, 1,2-dichloroethane, 1,1-dichloroethene, and chlorobenzene.

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SECTION 5

ALTERNATIVES

5.1 GENERAL

Based on the results of this investigation, 12 sites have been classified into one of three possible categories, as follows:

- Category I -- requiring no further action.
- Category II -- requiring further investigation.
- Category III -- requiring remedial action.

All the 12 sites fell into a subcategory of Category II. Five sites fell into category IIb, requiring monitoring of contaminant levels, one site fell into Category IIa, requiring further investigation, and the remaining sites fell into Category IIc requiring further investigation to expand the data base and quantify the magnitude and extent of contamination.

Table 5-1 summarizes the types of site investigation alternatives commonly available, listing the subcategories to which these alternatives would be applicable, conditions and rationale for applicability, and the specific sites at which the investigation alternative was found to be applicable. Three broad types of investigation alternatives have been identified in Table 5-1:

- Additional sampling at existing monitoring points.
- Use of nondestructive geophysical methods.
- Expansion of the monitoring network.

Of these, use of geophysical methods has been determined to have little applicability at Travis AFB for the following reasons:

- Hydrogeological conditions are not favorable for tracking a contaminant plume due to the abundance of interfingering lenses of silts and clays.

- The types of contaminants detected (mostly nonconductive organics) and background concentrations of conductive contaminants (chloride) to not readily lend themselves to these methods.

Table 5-1

Summary of Category II Investigation Alternatives

Investigation Alternative	Condition(s) of Applicability	Rationale for Applicability	Applicable Sites at Travis AFB
1. Additional sampling at existing monitor points only: • Increase number or frequency of sampling rounds. • Change sampling and analytical protocol.	Site has had an impact on surface or groundwater quality, but does not present unacceptable health or environmental hazards.	Long-term monitoring will confirm the absence of health and environmental hazards or provide early warning should such hazards develop in the future.	FTA-1 Landfill No. 3 Landfill No. 1 Landfill No. 2
2. Use of nondestructive geophysical methods (GPR, magnetometer, electrical resistivity, electromagnetic inductance).	Existing monitoring network is insufficient to confirm contamination resulting from past site use or operation.	Geophysical methods can provide initial screening of the site for contrasts in subsurface characteristics representing buried material or mineralized groundwater.	
	Contamination from the site has been confirmed, but additional data are required to quantify contamination.	Geophysical methods can be used to delineate the extent of a site and track contaminants migrating away from a site.	
	Data are sufficient to support a preliminary feasibility study, but further data are required for quantification.	Geophysical methods can be used to delineate the extent of a site and track contaminants migrating away from a site.	
3. Expansion of monitoring network followed by additional sampling at new and existing monitor points:	(As above)	Additional monitor points at critical locations can be used to complete confirmation study of a site.	JP-4 spill
• Collect additional soil samples. • Establish additional surface water sampling stations. • Install additional groundwater monitoring wells.	(As above) (As above) (As above)	Additional monitoring points provide new quantitative chemical data in the lateral and vertical dimensions for determining the distribution of contaminants in both dimensions, as a basis for eventual feasibility study.	Sewer Right-of-Way Oil Spill Area Solvent Spill Area FTA-3 FTA-4 STPZ

Therefore, the further site investigations recommended will depend primarily on additional sampling at existing and new monitor points. The subsection reviews the rationale affecting the selection of investigation alternatives and the development of specific recommendations at the 12 sites determined to require further investigation.

5.2 SITE-SPECIFIC ALTERNATIVES

5.2.1 Storm Sewer Zone Alternatives

5.2.1.1 Fire Training Area No. 1 Alternatives

Based on the results of this investigation, a small degree of soil contamination and groundwater contamination has been detected. The area is located near the barracks, however, contact with subsurface soils would be expected to be minimal. No water wells are downgradient or near this site. For this reason, continued monitoring of existing monitoring well MW-101 is recommended to track the contaminant levels.

5.2.1.2 Oil Spill Area Alternatives

Based on this investigation, high levels of contaminants were detected in both soils and groundwater at this site. The source appears to be the Cleaning and Degreasing Shop located in Building 18. Further investigation is required, including additional monitoring points, to evaluate the exact source, extent, and magnitude of contamination.

5.2.1.3 Solvent Spill Area Alternatives

Contamination has been detected at high levels in both soils and groundwater at this site. Additional monitoring wells need to be installed in order to further define the magnitude and extent of contamination.

5.2.1.4 Sewer Right-of-Way Alternatives

Based on the results of this investigation, the storm sewer system and adjacent monitoring wells are heavily contaminated with volatile organic compounds. This contamination is reaching Union Creek via the storm sewer system and at times is flowing off-Base via the creek. An intensive study of the storm sewer system, including additional surface-water and/or storm drain monitoring points and flow weirs, needs to be undertaken in order to pinpoint the sources of contamination.

5.2.2 Landfill No. 3 Alternatives

This investigation detected groundwater contamination by volatiles and pesticides below Federal and State standards. The area is remote and no supply wells are located in the downgradient direction. Periodic monitoring is required in order to track the contaminant levels.

5.2.3 JP-4 Spill Site Alternatives

Based on this investigation, the presence or absence of contamination is unconfirmed. At least one additional monitoring well needs to be installed in order to confirm the presence of contamination.

5.2.4 Sewage Treatment Plant Zone Alternatives

Based on this investigation, it has been determined that the STPZ is impacting the groundwater by inorganic and organic contamination with possible movement off-Base to the south where domestic, stock and irrigation wells are located. Elevated concentrations of nitrates in both downgradient wells have been identified. In addition, one downgradient well has been identified as having an elevated concentration of 1,2-dichloroethane. Further investigation, including sampling of off-Base wells, is required to positively identify the source and to evaluate the extent and magnitude of groundwater contamination.

5.2.5 Fire Training Area No. 4 Alternatives

This investigation detected contaminants in the surface water, stream sediments, soils, and groundwater. Many of the contaminants in the stream originate from the storm sewer system rather than FTA-4, although some may be coming from overland runoff from FTA-4. A berm system with lined ditches should be built around the site to stop and collect runoff before it enters the creek. Additional sampling is needed to define the magnitude and extent of groundwater contamination at the site.

5.2.6 North Landfill Zone Alternatives

5.2.6.1 Landfill No. 1 Alternatives

TCE was detected in MW-130, the monitoring well associated with Landfill No. 1. The levels were below the State Action Levels. Therefore, only periodic monitoring is required in order to track the contaminant levels.

5.2.6.2 Landfill No. 2 Alternatives

Based on the results of this investigation, groundwater has been slightly impacted by inorganic contaminants emanating from Landfill No. 2 and/or an off-Base source to the north. There are no producing wells downgradient of the site; therefore, only periodic monitoring is required in order to track the contaminant levels.

5.2.6.3 Fire Training Area No. 2 Alternatives

Based on the results of this investigation, the soils and groundwater at FTA-2 exhibit a minor amount of contamination. This site is fairly remote, and contact with subsurface soils is expected to be minimal. No producing wells are located downgradient; therefore, only periodic monitoring is required in order to track contaminant levels.

5.2.6.4 Fire Training Area No. 3 Alternatives

Both soil and groundwater samples indicate contamination with some contaminants in groundwater exceeding State Action Levels. However, no producing wells are located downgradient and contact with subsurface soils is expected to be minimal. Two additional monitoring wells need to be installed in order to determine the extent and magnitude of contamination.

SECTION 6

RECOMMENDATIONS

As a result of the IRP Phase II, Stage 1, investigation at Travis AFB, 12 sites were identified requiring further investigation either to complete the confirmation study or to further quantify the extent of contamination. Based on a review of the alternatives in Section 5, the two types of investigation alternatives applicable at Travis AFB are additional sampling at existing monitoring points only, and expansion of the monitoring network followed by additional sampling. The rationale for justifying selection of these alternatives has been reviewed in Section 5. This section presents recommendations for implementation of these alternatives on a site-by-site basis. The site-by-site recommendations are preceded by some general recommendations concerning the handling and disposal of hazardous substances, as well as further monitoring programs associated with the IRP.

6.1 GENERAL RECOMMENDATIONS

The following general recommendations are made:

- The presence of volatile organics and oil and grease/petroleum hydrocarbons in soils and sediments, and VOC's in the storm sewer system and Union Creek at Travis AFB suggest that discharge to these media is taking place and carrying hazardous substances, particularly solvents, fuels, and other petroleum by-products, into the environment. Discharge of washrack water has been identified as a potential source of substances being found in the storm sewer system and Union Creek. Therefore, it is recommended that all discharge of wash waters and nonaqueous substances directly to the soils or storm sewer system be curtailed, and that these solutions be routed to the appropriate sewer system for treatment.

- The shallow water table aquifer has been shown to be contaminated with volatile organics, pesticides, herbicides, and inorganic compounds. Of particular concern is the Sewage Treatment Plant Zone where it appears that inorganic and organic compounds may be moving off-Base toward domestic, stock, and irrigation wells.

- Of the analytes sampled in Stage 1, TOC and phenols were found at or near the detection limit. Furthermore, TOC exhibited little correlation with other organic compounds and, therefore, was of little use in data interpretation. It is recommended these parameters be dropped from future sampling and analytical protocols associated with site investigations at Travis AFB. Instead, it is recommended volatiles analysis become the principal analytical tool for investigation. At sites thought to be contributing a significant load of inorganics to groundwater, it is recommended that boron be added to the sampling and analytical protocol. In addition, new monitoring wells should be installed so as to capture any floating hydrocarbons and sampled for their presence. The samples should be submitted for petroleum hydrocarbon identification analysis. This analysis uses capillary gas chromatograph methods to "fingerprint" the product, which can then be compared to samples of known product for identification purposes.

6.2 SITE-SPECIFIC CONCLUSIONS AND RECOMMENDATIONS

6.2.1 Site-Specific Conclusions

As a conclusion to this investigation, each site investigated can be cateogrized according to whether it requires no further action (Category I), requires further investigation (Category II), or is ready for remedial action (Category III). Sites may be subsequently recategorized at the end of each successive stage of the Phase II investigation until all are ready for remedial action (Phase IV of the IRP investigation). Commonly, most of the sites fall into Category II at the end of the first stage of investigation. For this reason, Category II needs to be further subdivided to distinguish among the different types of investigation alternatives to be considered for each site. The following definitions have been used in the classification of investigation sites at Travis AFB:

- Category I applies to sites where no further action (including remedial action) is required because sufficient data exist to rule out unacceptable health or environmental risks resulting from the site.

- Category II applies to sites requiring further investigation to complete the confirmation study.

- Category III applies to sites where remedial action is required and all necessary data to support a feasibility study of remedial alternatives have been gathered. These sites are considered ready for IRP Phase IV action.

Site-by-site conclusions are summarized in Table 6-1, which lists a category for each site, presents rationale for the categorization, and references the report sections that present supporting evidence for that categorization.

6.2.2 Site-Specific Recommendations

Site-specific recommendations for further field investigations at the 12 sites have been summarized in Table 6-2. The rationale for recommending additional wells in the shallow aquifer is outlined in Sections 4 and 5. New monitoring wells should be constructed of the same materials used in Stage 1 monitoring wells; however, the inner diameter should be increased to 4 inches in wells used to evaluate the presence of floating hydrocarbons.

The rationale for the choice of analytes is given in Section 5 and Subsection 6.1. In general, the recommended frequency of sampling is quarterly, to be continued until Phase II investigations are completed and Phase IV is initiated, or until a site can be dropped into Category I based on two successive sampling rounds showing no evidence of unacceptable hazards.

The STPZ is the site of most immediate concern at Travis AFB because it poses the most direct potential threat to drinking water supplies. Contamination associated with the Sewage Treatment Plant has been fairly well defined within the Base boundaries on the basis of current information. The levels of nitrates being found and hydrologic data available to date suggest a potential for off-Base migration. Further investigation, including sampling of on-Base and possibly off-Base wells, is required to positively identify the source and evaluate the extent and magnitude of groundwater contamination.

In addition, the presence of volatiles, particularly TCE, in the storm sewer system poses a potential threat to Union Creek. An intensive investigation, including additional monitoring points in the storm sewer and a survey of shops disposing into the storm sewer, is recommended. The investigation of the SSZ should focus on identifying the location, nature, and present status of the source(s) of contamination.

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Table 6-1

Summary of Site-Specific Conclusions, Travis Air Force Base Stage 1 Investigation, IRP Phase II

Zone/Area	Investigation Cagetory	Rationale	Supporting Sections of Report
Storm Sewer Zone			
FTA-1	II	Soil samples indicate contamination present at low levels. Water quality data do not exceed standards. Monitoring of contaminant levels required.	4.3.1.1 4.4.2.1
Oil Spill Area	II	Soil samples indicate above background levels of oil and grease. Water quality data found various volatile organics, mainly TCE, exceeding standards. Two additional monitoring wells are needed.	4.3.1.1 4.4.2.1
Solvent Spill Area	II	Soil samples indicate contamination by oil and grease, and TCE. Water quality analyses found various volatile organics, mainly TCE, exceeding standards. Two additional monitoring wells are needed.	4.3.1.1 4.4.2.1
Sewer Right-of-Way	II	Soil, sediment, and water quality samples indicate major contamination by oil and grease, and volatile organics. Intensive investigation into sources needed.	4.3.1.1 4.3.2.1 4.4.2.1
Landfill No. 3	II	Water quality data indicate contamination below standards. Monitoring of contaminant levels required.	4.4.2.2
JP-4 Spill Area	II	Study results do not confirm or deny the area as a contamination source. At least one additional monitoring well needs to be installed.	4.4.2.3

Table 6-1
(continued)

Zone/Area	Investigation Cagetory	Rationale	Supporting Sections of Report
Sewage Treatment Plant Zone	II	Sediment samples indicate oil and grease in the stream. Water quality data indicate exceedances of standards and possible movement off-Base.	4.3.2.2 4.4.2.4
FTA-4	II	Sediment samples indicate above background levels of oil and grease in the stream. Water quality data indicate some exceedances of standards, but most are unconfirmed.	4.3.2.3 4.4.2.5
North Landfill Zone			
Landfill No. 1	II	Water quality data indicate contamination by TCE below standards. Monitoring of contaminant levels required.	4.4.2.6
Landfill No. 2	II	Water quality data indicate small amount of contamination emanating from site. Monitoring of contaminant levels required.	4.4.2.5
FTA-2	II	Soil samples indicate contamination by oil and grease, and TCE. Water quality data indicate some volatiles below standards, but unconfirmed.	4.3.1.4 4.4.2.6
FTA-3	II	Soil samples indicate contamination by oil and grease. Water quality data indicate some volatiles above standards, but unconfirmed. Two additional monitoring wells are needed.	4.3.1.4 4.4.2.6

Table 6-2

Summary of Investigation Recommendations

	Existing Monitoring Wells	Recommended New Monitoring Wells	Recommended New Surface-Water Sampling Points	Recommended Analytes in Water	Recommended Additional Field Activities
Storm Sewer Zone					
FTA-1	MW-101	--		VOA	
Oil Spill Area	MW-102, MW-103	2		Petroleum, hydrocarbons, VOA	
Solvent Spill Area	MW-104 MW-105 MW-106	2		Petroleum, hydrocarbons, VOA	
Sewer Right-of-Way	MW-107 through MW-112	--	All storm drains in contaminated zone.	Petroleum, hydrocarbons, VOA, base/ neutrals, acids	Equip storm drains with flow weirs.
Landfill No. 3	MW-113 MW-114 MW-115	--		Pesticides/ herbicides, VOA	
JP-4 Spill Site	MW-116	1		Petroleum, hydrocarbons, VOA	
FTA-4	MW-117 through MW-120			Petroleum, hydrocarbons, VOA	
Sewage Treatment Plant Zone	MW-121 through MW-124	--		VOA, potsbility factors, pesticides/herbicides, boron, metals	Off-Base well sampling.

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Table 6-2
(continued)

	Existing Monitoring Wells	Recommended New Monitoring Wells	Recommended New Surface-Water Sampling Points	Recommended Analytes in Water	Recommended Additional Field Activities
North Landfill Zone					
Landfill No. 1	MW-130	--		VOA	
Landfill No. 2	MW-125 through MW-129	--		VOA, potability factors, boron, metals	
FTA-2	MW-133 MW-134	--		Petroleum hydrocarbons, VOA	
FTA-3	MW-131 MW-132	2		Petroleum hydrocarbons, VOA	
Off-Base	---	1		VOA, potability factors, boron, metals, pesticides/herbicides	Install one well off-Base and upgradient for background concentrations.

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